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CONSULTATIVE PLANNING CONFERENCE ON AIRCRAFT SEPARATION ASSURAN--ETC(U)
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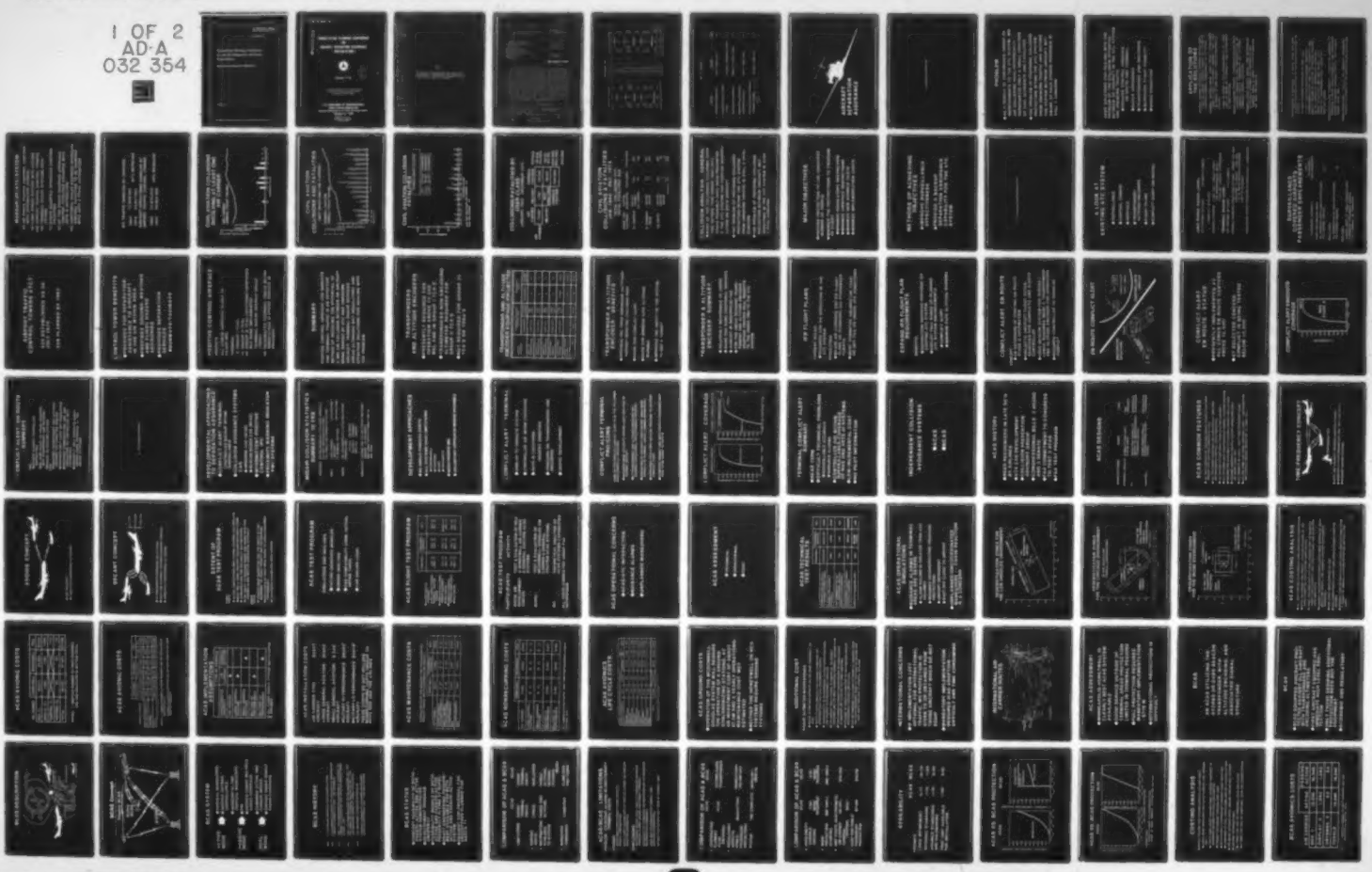

AD-A032 354

Consultative Planning Conference on Aircraft Separation Assurance: Presentations

Federal Aviation Administration Washington D C

27 Sep 76

Report No. FAA-ATF-4-76-1

CONSULTATIVE PLANNING CONFERENCE ON AIRCRAFT SEPARATION ASSURANCE: PRESENTATIONS

September 27, 1976

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Associate Administrator for Air Traffic and Airway Facilities
Washington, D.C. 20590

NOTICE

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15. Supplementary Notes

PRICES SUBJECT TO CHANGE

16. Abstract

This document contains the vu-graphs presented at the Consultative Planning Conference of September 27, 1976 on the FAA's Aircraft Separation Assurance Program. The purpose of this conference was to inform and solicit comments from the aviation user groups on the FAA's proposed Aircraft Separation Assurance Program. The first section includes a review and analyses of pertinent statistical information on collisions and collision analyses, major separation assurance objectives, protection priorities, and methods of achieving objectives. The second section, Existing Air Traffic Control System, reviews the procedures and systems being used today related to aircraft separation. The third section, Developmental Approaches, contains information on conflict alert in the terminal environment, Collision Avoidance Systems (CAS) including Airborne CAS (ACAS) and Beacon-Based CAS (BCAS), Intermittent Positive Control (IPC) and Proximity Warning Indicator (PWI) systems. In Comparison of Overlapping Development Programs, the fourth section, information is given concerning FAA's selection of BCAS and IPC as the programs to pursue as well as FAA's decision not to proceed with ACAS and PWI. The final section, the recommended five-point Aircraft Separation Assurance Program, includes the plans, proposed schedules, interrelationships with other programs, cost and present status of (1) conflict alert in the terminal environment, (2) IFR flight Plan requirements (3) transponders and encoding altimeters, (4) BCAS, and (5) IPC.

17. Key Words	18. Distribution Statement
Midair Collisions ACAS (Airborne Collision Avoidance Sys) BCAS (Beacon Collision Avoidance Sys) IPC (Intermittent Positive Control) PWI (Proximity Warning Indicator)	Document is available to the public through National Technical Information Service, Springfield, Virginia 22151.

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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

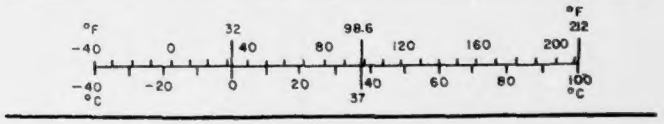
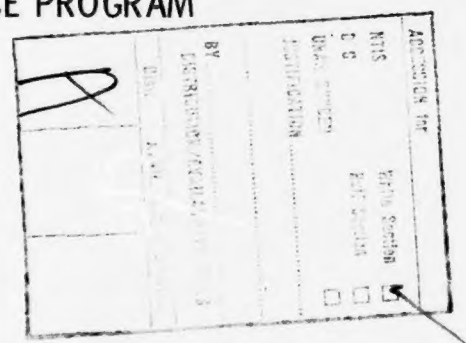


TABLE OF CONTENTS



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AIRCRAFT SEPARATION ASSURANCE

A. BACKGROUND INFORMATION

PROBLEM

- AS A RESULT OF CONTINUOUS SERIES OF IMPROVEMENTS TO THE ATC SYSTEM, MID AIR COLLISIONS HAVE HISTORICALLY REPRESENTED ONLY A SMALL FRACTION OF CIVIL ACCIDENTS AND FATALITIES
- THE PROBLEM OF PROVIDING COLLISION PROTECTION WITHIN THE ATC SYSTEM FROM UNKNOWN TRAFFIC AND OUTSIDE THE SYSTEM BETWEEN AIRCRAFT NOT AWARE OF EACH OTHERS PRESENCE IS STILL A CONCERN

SOME SOLUTIONS FOR DEALING WITH THE PROBLEM OF THE COLLISION POTENTIAL BETWEEN AN AIRCRAFT IN THE ATC SYSTEM AND UNKNOWN TRAFFIC

- POSITIVE CONTROL AIRSPACE - EN ROUTE AND TERMINAL
- RADAR ADVISORIES
- TRANSPONDERS AND ENCODERS
- INCREASED FLIGHT VISIBILITY
- SPEED REDUCTION

APPLICATION OF THE SOLUTIONS

POSITIVE CONTROL EN ROUTE - STARTED IN 1958 WITH POSITIVE CONTROL ROUTES. AUGUST 1971 FLOOR OF POSITIVE CONTROL THROUGHOUT U.S. AT 18,000.

TERMINAL CONTROL AREAS - FIRST GROUP I ESTABLISHED JUNE 25, 1970, AT ATLANTA. JANUARY 1, 1974, LAST OF SERIES OF NINE GROUP I TCAS ESTABLISHED AT DALLAS.

FIRST OF GROUP II TCAS ESTABLISHED AT ST. LOUIS. LAST OF SERIES OF 12 GROUP II TCAS ESTABLISHED AT NEW ORLEANS.

RADAR ADVISORY SERVICE - STARTED IN THE EN ROUTE AIRSPACE JANUARY 25, 1959. PROVIDED BY ALL 20 DOMESTIC ARTCCS PROVIDED BY ALL 171 RADAR APPROACH CONTROL FACILITIES

TERMINAL RADAR SERVICE AREAS - FIRST INTRODUCED IN ATLANTA OCTOBER 1962 PROVIDED AT 69 TERMINAL AREAS 42 GROUP III TCAS DESIGNATED BUT NONE IMPLEMENTED.

TRANSPONDERS & ENCODERS - STARTED USING THE FIRST 64 CODE BEACON SYSTEM IN THE NEW YORK AREA IN 9/10/59.

20 SUCH SYSTEMS INSTALLED BY MAY 1960.

7/1/75 - FAR EFFECTIVE REQUIRING IMPROVED TRANSPONDERS WITH 4096 CODE CAPABILITY AND MODE C AUTOMATIC ALTITUDE REPORTING ENCODER ON ALL FLIGHTS IN CONTROLLED AIRSPACE ABOVE 12,500 FEET MSL AND GROUP I TCAS. GROUP II'S TRANSPONDER ONLY. GROUP III'S TWO WAY RADIO.

INCREASED FLIGHT VISIBILITY - 3/16/58 FAR AMENDED TO REQUIRED 5 MILES FLIGHT VISIBILITY AND INCREASED CLOUD CLEARANCE DISTANCE FOR ALL VFR FLIGHTS ABOVE 10,000 MSL.

SPEED REDUCTION - 12/15/67 FAR AMENDED PROHIBITING SPEEDS IN EXCESS OF 250 KNOTS BELOW 10,000 MSL.

MAKEUP OF ATC SYSTEM

20 AIR ROUTE TRAFFIC CONTROL CENTERS WITH AUTOMATION (CONUS)

101 LONG RANGE RADARS WITH ATCRBS

426 AIRPORT TRAFFIC CONTROL TOWERS

156 TERMINAL RADAR SYSTEMS WITH ATCRBS

171 RADAR EQUIPPED APPROACH CONTROL FACILITIES

63 OF THE RADAR EQUIPPED APPROACH CONTROL FACILITIES EQUIPPED WITH ARTS III AUTOMATION

105 ADDITIONAL RADAR EQUIPPED APPROACH CONTROL FACILITIES TO BE EQUIPPED WITH ARTS II TPX42 AUTOMATION

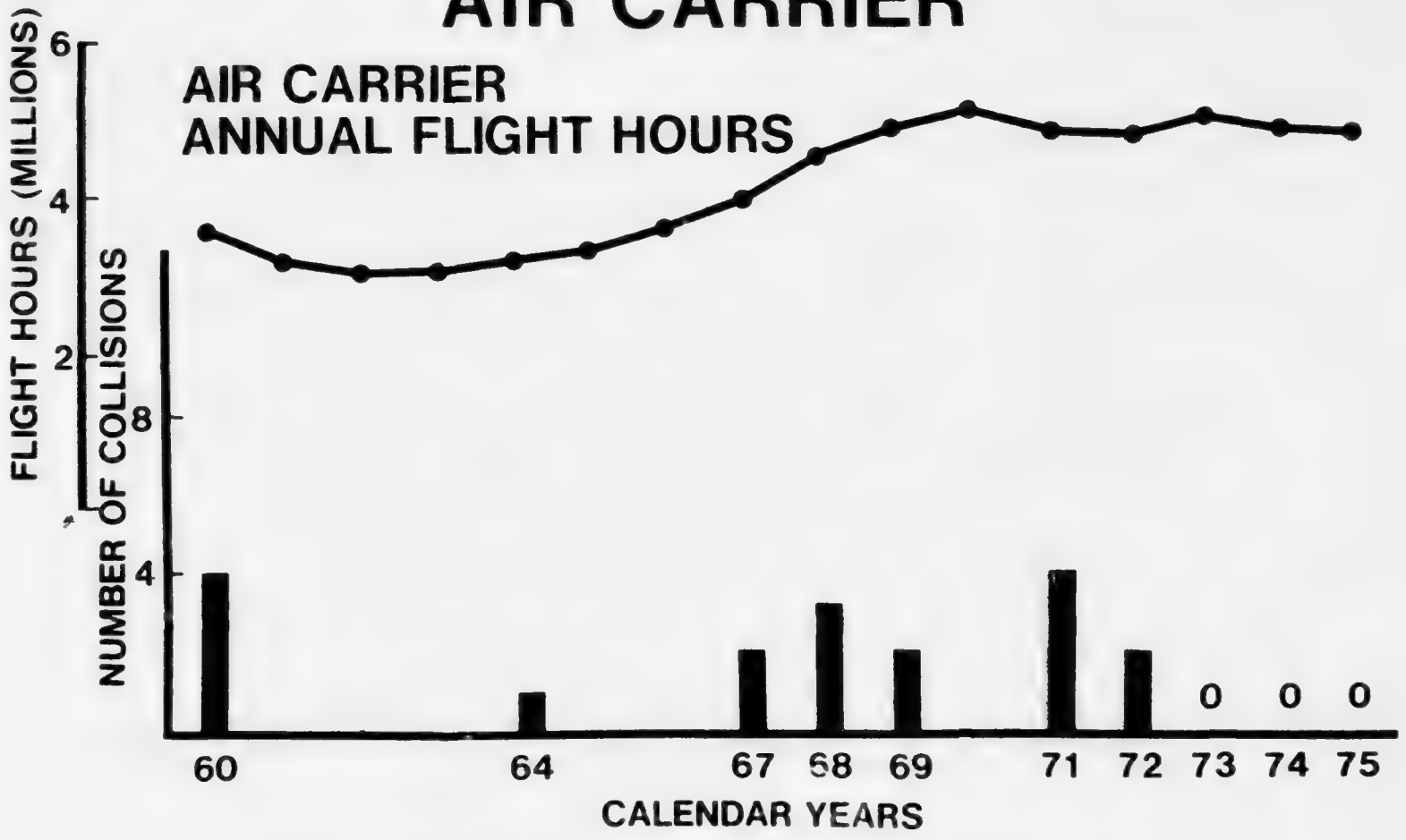
IFR TRAFFIC HANDLED BY CENTERS

1965	12,859,018	87% INCREASE
1975	23,617,503	

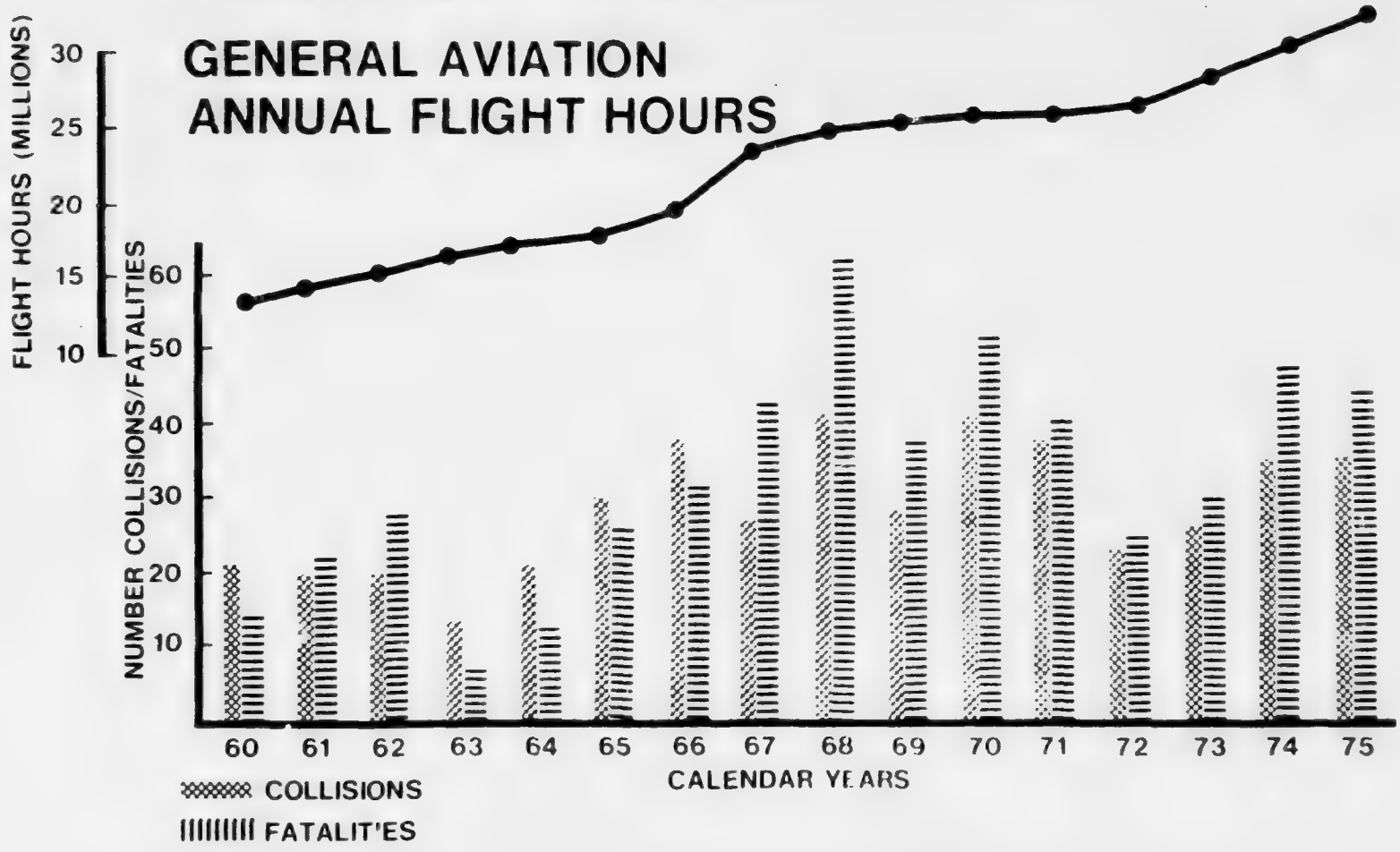
AIRCRAFT OPERATIONS HANDLED BY AIRPORT TRAFFIC CONTROL TOWERS

1965	37,870,535	58% INCREASE
1975	59,962,468	

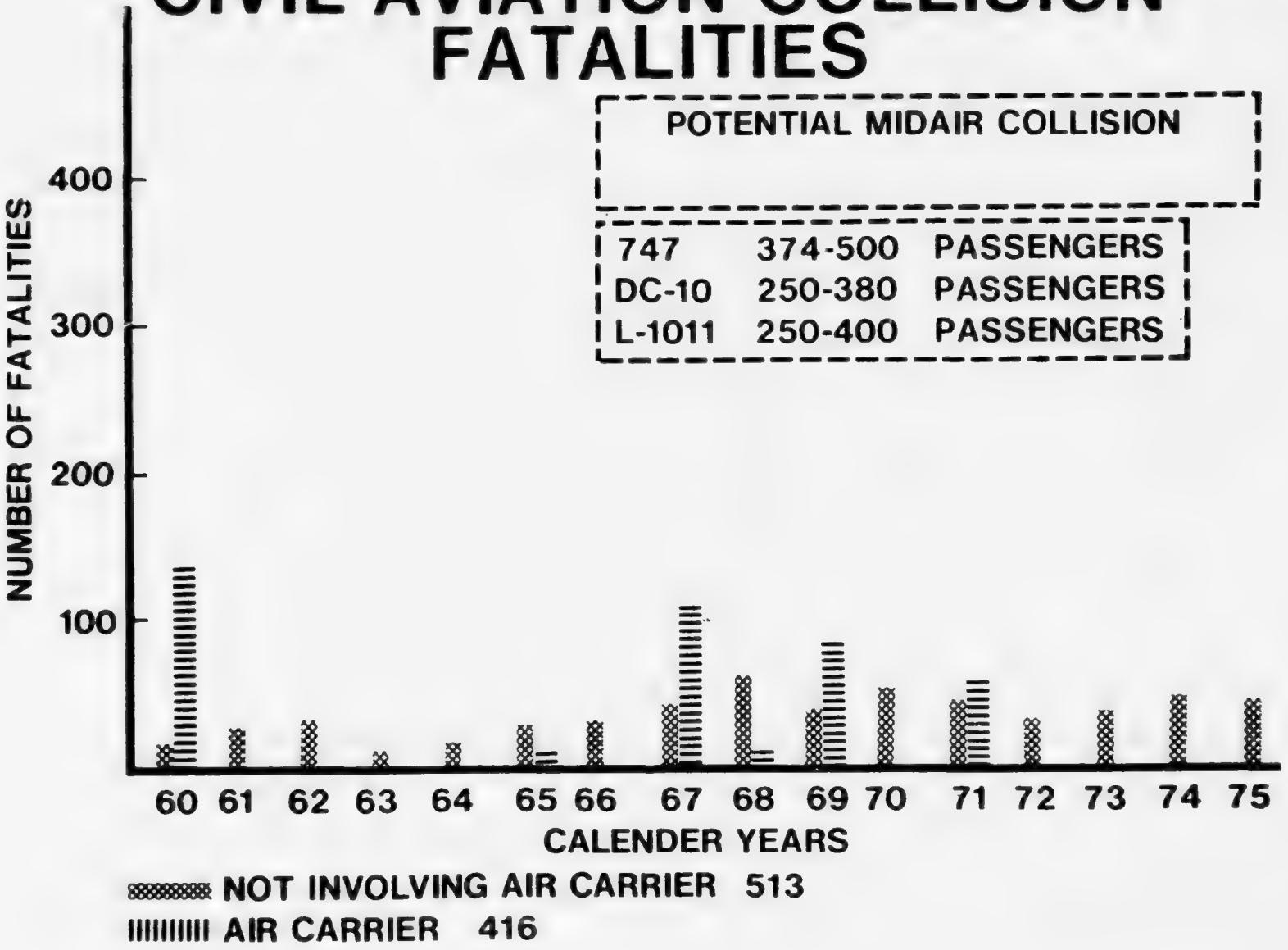
CIVIL AVIATION COLLISIONS INVOLVING AT LEAST ONE AIR CARRIER



CIVIL AVIATION
COLLISIONS AND FATALITIES
(NOT INVOLVING AIR CARRIER)



CIVIL AVIATION COLLISION FATALITIES



COLLISIONS/FATALITIES BY USER CLASS

JANUARY 1960 - DECEMBER 1975

	AIR CARRIER	MILITARY	GENERAL AVIATION	TOTALS
AIR CARRIER	3/148	1/50	14/218	18/416 4%/45%
MILITARY		NOT ANALYZED	28/52	28/52 6%/6%
GENERAL AVIATION			424/460	424/460 90%/49%
				470/928

CIVIL AVIATION COLLISIONS & FATALITIES JAN. 1960 - DEC. 1975

TOTAL COLLISIONS 470
TOTAL FATALITIES 928

WHERE THEY OCCURRED	SYSTEM CONDITIONS	COLLISIONS	FATALITIES
AT AIRPORTS	NO ATC TOWER	245	163
	ATC TOWER	57	95
IN TERMINAL AREAS	VFR/IFR	16	147
	IFR/IFR	2	216
EN ROUTE	VFR/VFR	144	242
	VFR/IFR	5	61
	IFR/IFR	1	4
	TOTALS:	470	928

COLLISION ANALYSIS - GENERAL

- MANY OF THE COLLISIONS OCCURING OVER THIS FIFTEEN YEAR PERIOD 1960-1975, COULD POSSIBLY HAVE BEEN PREVENTED IF THE ATC SYSTEM HAD POSITIVE IDENTIFICATION ON BOTH AIRCRAFT

- THE PROBLEM OF PROVIDING COLLISION PROTECTION WITHIN THE ATC SYSTEM FROM UNKNOWN TRAFFIC IS STILL A VITAL CONCERN

- THE PROBLEM OF PROVIDING COLLISION PROTECTION BETWEEN AIRCRAFT NOT OPERATING IN THE ATC SYSTEM IS ALSO A VITAL CONCERN

MAJOR OBJECTIVES

- PROVIDE PROTECTION TO THE GREATEST NUMBER OF PEOPLE
- MINIMIZE THE RESTRICTIONS TO FREEDOM OF FLIGHT
  - MINIMIZE REGULATORY RESTRICTION
  - MINIMIZE AIRSPACE RESTRICTIONS
  - MINIMIZE NEW AVOINCS COSTS
  - MINIMIZE IMPLEMENTATION COSTS

METHODS OF ACHIEVING OBJECTIVES

- IMPROVE SURVEILLANCE EFFECTIVENESS
- PROVIDE A BACKUP SEPARATION ASSURANCE CAPABILITY FOR THE ATC SYSTEM

B. EXISTING AIR TRAFFIC CONTROL SYSTEM

A LOOK AT EXISTING ATC SYSTEM

- SURVEILLANCE
- CONTROL TOWERS
- AIRSPACE
- TRANSPONDER/ ALTITUDE ENCODERS
- FLIGHT PLANS
- CONFLICT ALERT (EN ROUTE)

LONG RANGE RADAR (ARSR)

101 SYSTEMS IN PLACE 23 MORE PLANNED

WHEN ALL IN PLACE

GENERAL COVERAGE - 3,000 AGL (CONUS) EXCEPT
FOR MOUNTAINOUS AREAS
7,000 AGL (CONUS) CONTINUOUS

TERMINAL RADAR (ASR)

156 SYSTEMS IN PLACE 44 PLANNED

GENERAL COVERAGE FROM EACH SYSTEM - ABOVE 500 AGL
FOR FIRST 15 MILES - 1,200 AGL
TO 30 MILES BEACON COVERAGE
OUT TO 60 MILES

LONG RANGE RADAR PROGRAM IS ESSENTIALLY COMPLETED.

SURVEILLANCE COVERED AIRPORTS - PASSENGER ENPLANEMENTS

PASSENGER AIRPORTS	1974 PASSENGER ENPLANEMENTS
LARGE AND MEDIUM HUBS	
86 AIRPORTS WITH CAB-CERTIFICATED AIR CARRIER SERVICE	87%
SMALL-HUBS	
85 AIRPORTS WITH CAB-CERTIFICATED AIR CARRIER SERVICE	9%
NON-HUBS	
SURVEILLANCE AT SOME AIRPORTS WITH SCHEDULED PASSENGER SERVICE (AIR CARRIERS OR COMMUTER)	4%

AIRPORT TRAFFIC CONTROL TOWERS ATCT

426 ESTABLISHED AS OF JULY 1976

459 PLANNED BY 1982

CONTROL TOWER BENEFITS

- PROVIDES FOR SEPARATION ASSISTANCE TO AIRCRAFT IN THE AIR WITHIN AREA
- PROVIDES GROUND, WEATHER AND FLIGHT HAZARD ADVISORIES
- PROVIDES SEPARATION SERVICES
  - RUNWAYS/TAXIWAYS

POSITIVE CONTROL AIRSPACE

ENROUTE

ALL CONUS AIRSPACE 18,000 TO 60,000 MSL

TERMINAL

9 GROUP I TCAs

12 GROUP II TCAs

42 GROUP III TCAs LOCATIONS IDENTIFIED BUT NONE IMPLEMENTED

TERMINAL RADAR SERVICE AREAS (TRSA)

69 DESIGNATED TERMINAL AREAS WITHIN WHICH STAGE III RADAR SERVICE IS PROVIDED

SUMMARY

POSITIVE CONTROL AIRSPACE FOR ENROUTE AND TERMINAL TRAFFIC IS AN EFFECTIVE METHOD OF REDUCING THE POTENTIAL OF A MID AIR COLLISION BETWEEN AN AIRCRAFT BEING SERVED BY ATC AND UNKNOWN AIRCRAFT. TERMINAL RADAR SERVICES AREAS ALTHOUGH NOT REGULATORY ARE EFFECTIVE SOLUTIONS FOR DEALING WITH THE PROBLEM.

TRANSPONDERS AND ALTITUDE ENCODERS

- PRESENTLY REQUIRED FOR OPERATION ABOVE 12,500 MSL AND IN GROUP I TCA'S
- TRANSPONDERS NON-ENCODING ALTIMETER REQUIRED FOR GROUP II TCA'S
- NOT REQUIRED FOR GROUP III TCA'S OR TRSA'S

TRANSPONDER AND ALTITUDE ENCODER EQUIPAGE-PROJECTED

AIRCRAFT CATEGORIES	VOLUNTARY PROJECTED EQUIPAGE 1985		UNEQUIPPED 1985	
	TRANSPONDER	ALTITUDE ENCODER	TRANSPONDER	ALTITUDE ENCODER
PUBLIC AIR TRANSPORTATION	4900 (100%)	4900 (100%)	0	0
FEDERAL AIR TRANSPORTATION	2200 (100%)	2200 (100%)	0	0
PRIVATE AIR TRANSPORTATION	6000 (100%)	6000 (100%)	0	0
OTHER FEDERAL AIRCRAFT	20,000 (100%)	20,000 (100%)	0	0
OTHER GENERAL AVIATION	151,520 (85%)	75,000 (40%)	37,800	113,640
AIRCRAFT WITHOUT AVIONICS	0 (0%)	0 (0%)	36,500	36,500
TOTALS	184,620	108,860	74,380	150,140

TRANSPONDER & ALTITUDE ENCODER - BENEFITS

- PROVIDES THE THIRD DIMENSION (ALTITUDE) THEREBY REDUCING COLLISION RISK
- BASIS FOR CONFLICT ALERT
- BASIS FOR MINIMUM SAFE ALTITUDE WARNING
- IMPROVES THE ABILITY OF THE SYSTEM TO SEE A TARGET

TRANSPONDER & ALTITUDE ENCODER - SUMMARY

- RELATIVELY INEXPENSIVE TO USERS
- BASIS FOR SOME ADDITIONAL SERVICES
- ALREADY IN WIDESPREAD USE
- FOR THE ABOVE REASONS TRANSPONDER AND ALTITUDE ENCODER EQUIPAGE PROVIDE REAL BENEFITS TO THE USERS AND TO THE ATC SYSTEM

IFR FLIGHT PLANS

CURRENT RULES:

- REQUIRED FOR IFR OPERATION IN THE ATC SYSTEM

APPLICATION:

- MAJOR AIR CARRIERS USE IFR FLIGHT PLANS AS STANDARD ALL PASSENGER FLIGHTS
- MOST COMMUTER AIRLINES/AIR TAXIS DO NOT FILE IFR UNDER VFR CONDITIONS

EXPAND IFR FLIGHT PLAN REQUIREMENTS

BENEFITS:

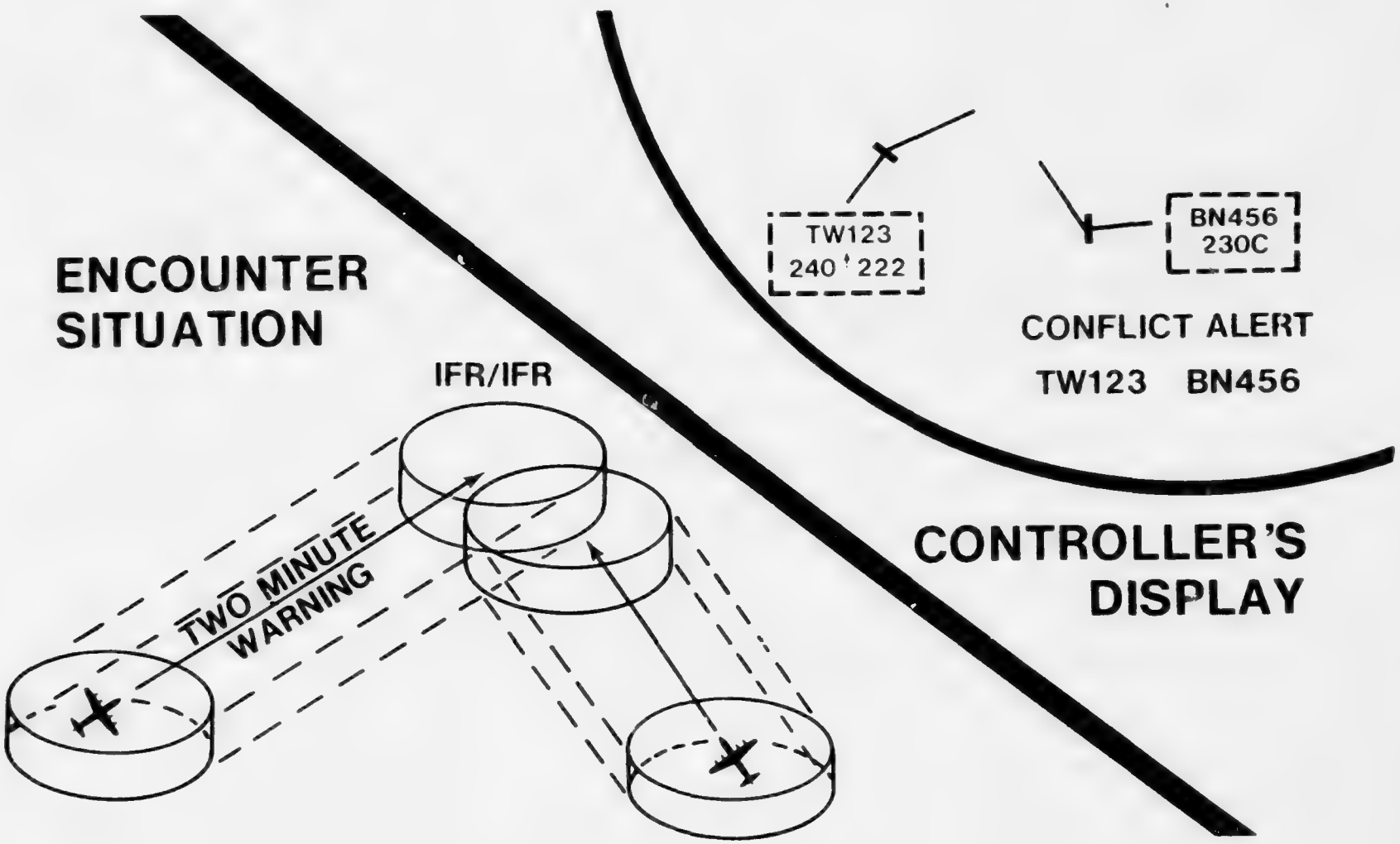
- SEPARATION SERVICES PROVIDED BY EXISTING ATC SYSTEM
- EXPLOIT FULL RANGE OF PLANNED ATC SYSTEM ENHANCEMENTS
  - CONFLICT ALERT
  - MINIMUM SAFE ALTITUDE WARNING

CONFLICT ALERT EN ROUTE

CONCEPT

- AN EXTENSION OF EXISTING EN ROUTE STAGE A AUTOMATION
- PROJECTS AIRCRAFT FLIGHT PATHS, SEARCHES FOR CONFLICTS AND ALERTS CONTROLLER
- USES BEACON SYSTEM FOR SURVEILLANCE. REQUIRES MODE C TRANSPONDER AND ALTITUDE ENCODER FOR OPERATION
- REQUIRES CONTROLLER TO RESOLVE CONFLICT

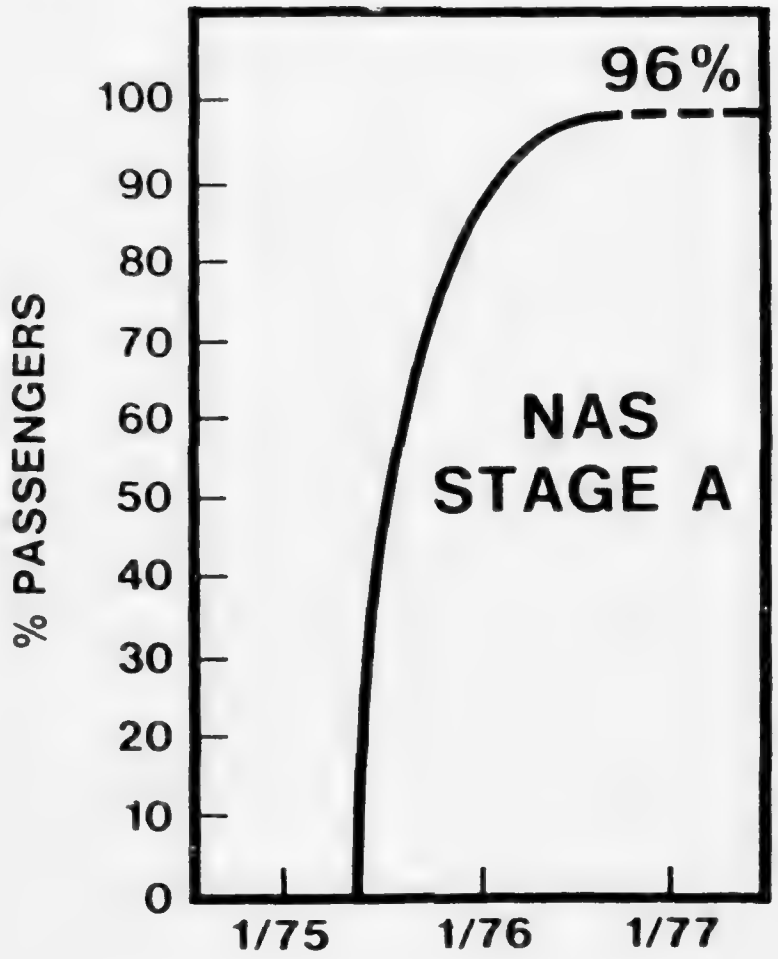
EN ROUTE CONFLICT ALERT



CONFLICT ALERT
EN ROUTE - STATUS

- PRESENTLY IMPLEMENTED AT ALL CONUS EN ROUTE CENTERS ABOVE 12,500′
- AT SELECTED CENTERS CONFLICT IS BEING TESTED BELOW 12,500′

CONFLICT ALERT(ENROUTE) COVERAGE



CONFLICT ALERT EN ROUTE - SUMMARY

PRO

- GUARDS AGAINST CONTROLLER DISTRACTION
- NO USER COSTS TO THOSE EQUIPPED WITH TRANSPONDER AND ENCODER
- BUILDS ON EXISTING SYSTEM

CON

- REQUIRES TRANSPONDER AND ALTITUDE ENCODER FOR EFFECTIVE SERVICE
- PROVIDES ONLY ALERT NOT RESOLUTION
- REQUIRES COMMUNICATION LINK AND RESOLUTION VIA CONTROLLER (NOT AUTOMATIC)
- PRESENTLY ONLY WITHIN EN ROUTE SURVEILLANCE COVERAGE AT THE HIGHER ALTITUDES

C. DEVELOPMENTAL APPROACHES

DEVELOPMENTAL APPROACHES TO SEPARATION ASSURANCE

- CONFLICT ALERT (TERMINAL)
  - CONTROLLER BACKUP WITHIN SURVEILLANCE
- COLLISION AVOIDANCE SYSTEMS (CAS)
  - AIRBORNE CAS (ACAS)
  - BEACON BASED CAS (BCAS)
- INTERMITTENT POSITIVE CONTROL (IPC)
- PROXIMITY WARNING INDICATOR (PWI) SYSTEMS

MIDAIR COLLISION STATISTICS SUMMARY 10 YRS

AVERAGES: 29 COLLISIONS/60 FATALITIES ANNUALLY
5% CIVIL AVIATION FATALITIES
13% PUBLIC AIR CARRIER FATALITIES

WHO:
1 AIR CARRIER — 30 FATALITIES
1 MILITARY / 27 GENERAL AVIATION — 30 FATALITIES

WHERE: 33% ACCIDENTS/75% FATALITIES WITHIN SURVEILLANCE

7%/15%	EN ROUTE
30%/62%	TERMINAL
54%/17%	AIRPORT

SENSITIVITY: FIFTEEN YRS: 417 PAT FATALITIES FROM MIDAIRS - 18 ACCIDENTS
ONE JUMBO WOULD DOUBLE THIS IN ONE EVENT

DEVELOPMENT APPROACHES

- NO SINGLE PANACEA EXISTS
- ALL SYSTEMS HAVE LIMITATIONS
  - PERFORMANCE
  - COVERAGE
  - COST
  - AVAILABILITY
- NEED PROPER MIX
- VOLUNTARY APPROACH WHERE POSSIBLE

CONFLICT ALERT - TERMINAL

- SIMILAR TO ENROUTE SYSTEM
- CONTROLLER AID WITHIN COVERAGE
- ARTS III LOCATIONS

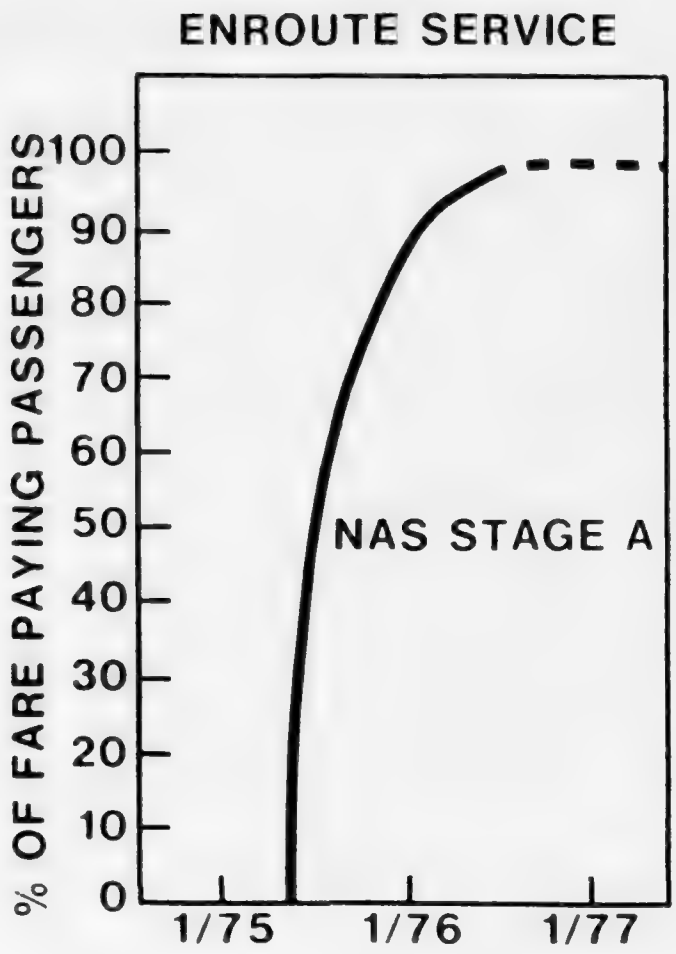
  HIGHEST DENSITIES
- TRIGGERS ON TRANSPONDERS AND ENCODERS
- UNIVAC DEVELOPMENT

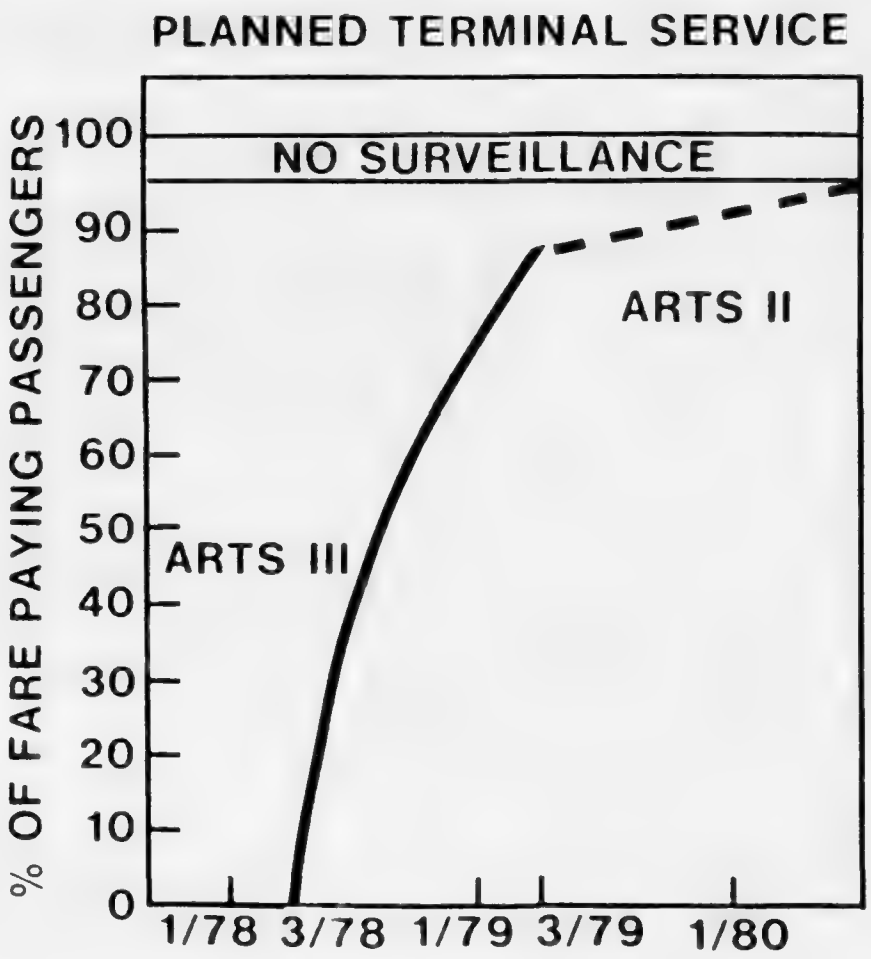
CONFLICT ALERT TERMINAL PRO/CONS

SAME AS FOR ENROUTE CONFLICT ALERT PLUS THE FOLLOWING DEVELOPMENTAL PROBLEMS:

- REQUIRES MORE ACCURATE SURVEILLANCE BECAUSE OF TURNING AIRCRAFT
- IF TRANSPONDERS AND ALTITUDE ENCODERS NOT REQUIRED OPERATIONAL EFFECTIVENESS REDUCED
- PREDICTION OF AIRCRAFT FLIGHT INTENT MUCH MORE DIFFICULT IN TERMINAL AREAS (TURNING MANEUVERS)
- UPGRADING ARTS II WITH BEACON TRACKING TO SUPPORT CONFLICT ALERT
- COMPUTER MEMORY AND INPUT/OUTPUT PROCESSOR MAY HAVE TO BE ADDED TO ARTS III

CONFLICT ALERT - COVERAGE





TERMINAL CONFLICT ALERT SUMMARY

- NEAR TERM
- DIFFICULT TECHNICAL PROBLEMS
  - SURVEILLANCE ACCURACY
  - NUISANCE ALARMS
- CONTROLLER AID WITHIN SURVEILLANCE-COVERAGE OF NAS AND ARTS III SYSTEMS
- LOW-INCREMENTAL COST
- NO PILOT INFORMATION

INDEPENDENT COLLISION AVOIDANCE SYSTEMS

- ACAS
- BCAS

ACAS HISTORY

- NEED RECOGNIZED IN LATE 50'S BY AIRLINES
- ATA CAS DEVELOPMENT
- COLLISION PREVENTION ADVISORY GROUP
- CONGRESSIONAL BILLS (3 HOUSE AND 2 SENATE)
- FAA COMMITMENT TO CONGRESS TO TEST 3 ACAS
- FAA TEST PROGRAM

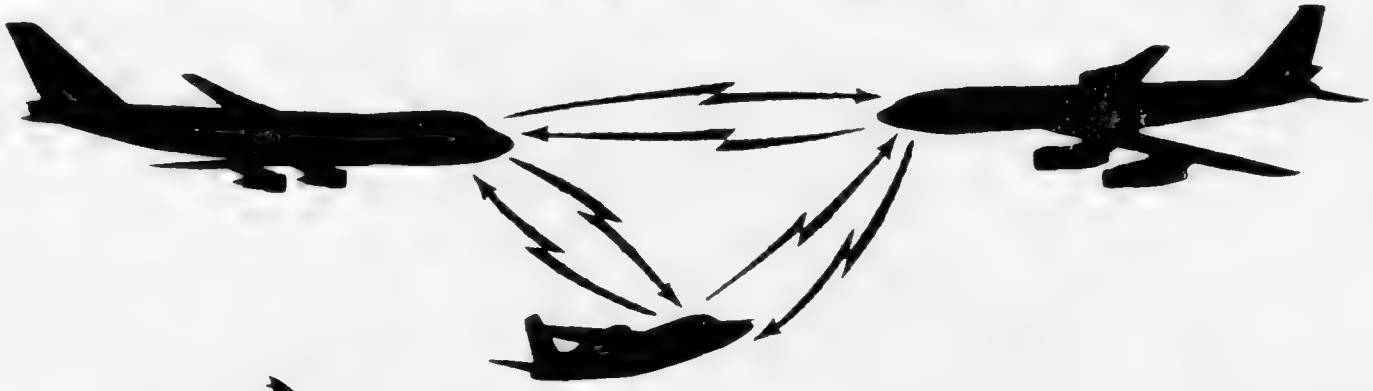
ACAS DESIGNS

MANUFACTURER	NAME	TYPE
MCDONNELL-DOUGLAS	ELIMINATE RANGE ZERO SYSTEM (EROS)	TIME/ FREQUENCY
RCA	SEPARATION CONTROL OF AIRCRAFT BY NONSYNCHRONOUS TECHNIQUES (SECANT)	INTERROGATE/ TRANSPONDER
HONEYWELL	AVIONIC OBSERVATION OF INTRUDER DANGER SYSTEM (AVOIDS)	INTERROGATE/ TRANSPONDER

ACAS COMMON FEATURES

- ALL ARE COOPERATIVE (REQUIRE SIMILAR AVIONICS ON OTHER AIRCRAFT FOR THE SOLE PURPOSE OF CAS)
- ALL AIR CARRIER VERSIONS USE SAME DISPLAY (MODIFIED INSTANTANEOUS VERTICAL SPEED INDICATOR)
- ALL OBTAIN ALTITUDE INPUT FROM ALTITUDE ENCODER
- ALL SYSTEMS HAVE LESS EXPENSIVE GENERAL AVIATION VERSION
- INFORMATION AVAILABLE TO SYSTEM IS RANGE AND ALTITUDE
- SYSTEMS GENERATE VERTICAL ESCAPE MANEUVERS ONLY (UP, DOWN, LEVEL OFF)
- ALL OPERATE IN 1592.5 – 1622.5 MHZ FREQUENCY BAND
- ALL USE SAME COLLISION AVOIDANCE LOGIC – AIR NAVIGATION AND TRAFFIC CONTROL REPORT NO. 117 (ANTC 117)

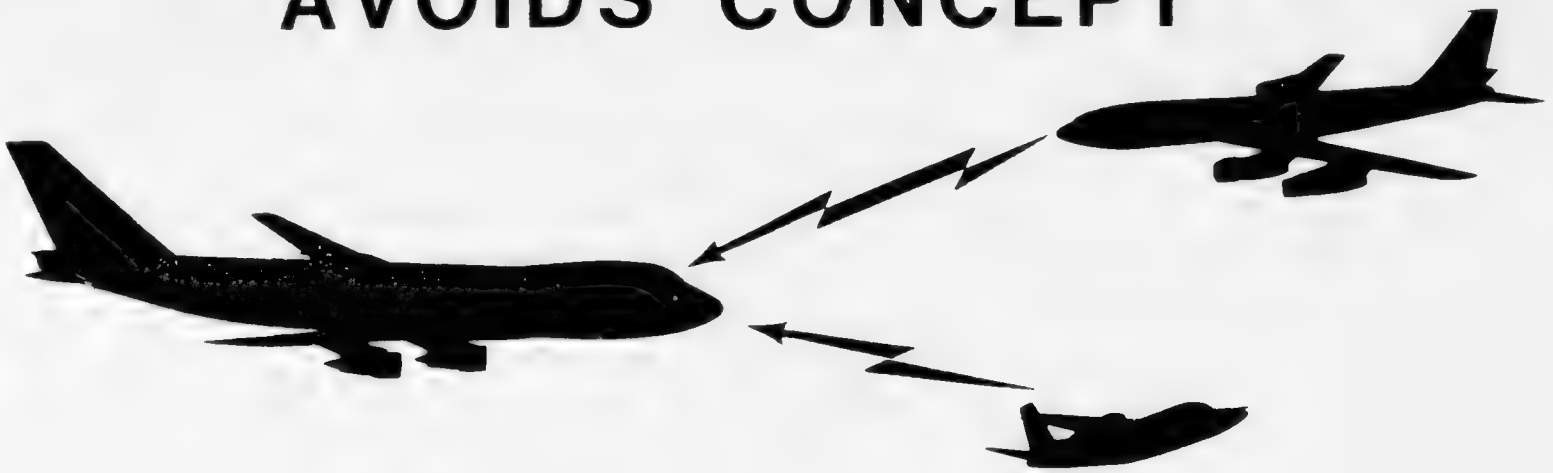
TIME/FREQUENCY CONCEPT



SYNCHRONIZATION

- DATA LINK CAPABILITY BETWEEN EQUIPPED AIRCRAFT
- OPERATES AT FOUR FREQUENCIES, 1600, 1605, 1610, 1615
- REQUIRES GROUND STATIONS

AVOIDS CONCEPT



- ONE FREQUENCY
- COMPLETELY INDEPENDENT OF GROUND

SECANT CONCEPT

- 24 FREQUENCIES DEPENDING ON ALTITUDE
- DATA LINK CAPABILITY BETWEEN EQUIPPED AIRCRAFT
- COMPLETELY INDEPENDENT OF GROUND

EXTENT OF ACAS TEST PROGRAM

FLIGHT TESTS

- ACTUAL ENCOUNTERS WERE FLOWN UTILIZING CAS DISPLAYS
- BOTH TWO & THREE AIRCRAFT ENCOUNTERS WERE FLOWN
- COMMUNICATION LINK RELIABILITY WAS MEASURED
- THE ABILITY TO MEASURE RANGE AND RANGE RATE WAS VERIFIED ALONG WITH ITS ASSOCIATED ACCURACY

BENCH TESTS

- TARGETS WERE GENERATED AND THE ABILITY OF THE EQUIPMENT TO TRACK AIRCRAFT WAS ESTABLISHED
- HIGH LEVELS OF FRUIT WERE ADDED TO CHECK EQUIPMENT PERFORMANCE
- ELECTRONIC PARAMETERS WERE VERIFIED

ACAS TEST PROGRAM

SIMULATIONS AND ANALYSES

- FUTURE DENSITIES MODELED
- ERROR ANALYSIS
- CAS COMPATIBILITY USING ACTUAL ARTSIII TAPES
- CAS ESCAPE LOGIC

ACAS FLIGHT TEST PROGRAM

	HONEYWELL	MCDONNELL-DOUGLAS	RCA
● ACCEPTANCE OF EQUIPMENT			
● AIR CARRIER VERSION	JAN. 74	OCT. 74	MAY 73
● GENERAL AVIATION VERSION	APRIL 75	OCT. 74	OCT. 75
● COMPLETE AIR CARRIER VERSION EQUIPMENT	OCT. 74	OCT. 75	MARCH 74
● FINAL REPORT	MAY 75	SEPT. 76	NOV. 74
● COMPLETE GENERAL AVIATION FLIGHT TESTS	OCT. 75	OCT. 75	DEC. 75
● FINAL REPORT	SEPT. 76	SEPT. 76	SEPT. 76

ACAS TEST PROGRAM

PARTICIPANTS	ACTIVITY
NAVAL AIR DEVELOPMENT CENTER	TEST & EVALUATION OF RCA & HONEYWELL AIR CARRIER & GENERAL AVIATION ACAS SYSTEMS
NAFEC	TEST & EVALUATION OF MCDONNELL- DOUGLAS AIR CARRIER & GENERAL AVIATION ACAS SYSTEMS
IDA	THEORETICAL ANALYSIS OF ACAS SYSTEMS CAPABILITIES

ALL TESTS CONDUCTED UNDER FAA SUPERVISION

ACAS OPERATIONAL CONCERNS

- ACAS/ATC INTERACTION
- NUISANCE ALARMS
- UNPLANNED MANEUVERS

ACAS ASSESSMENT

- TECHNICAL
- OPERATIONAL
- COST

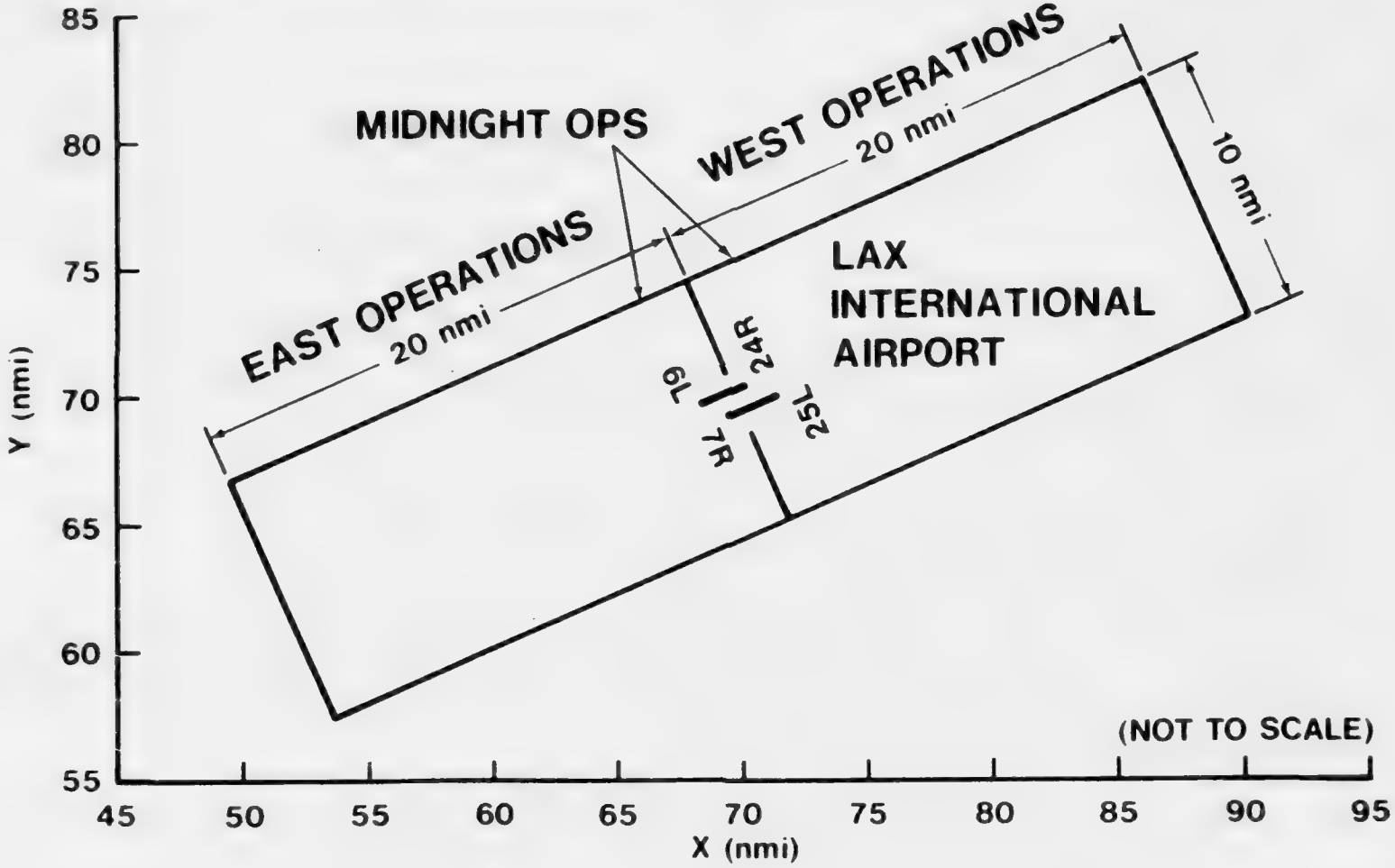
ACAS TECHNICAL TEST RESULTS

	HONEYWELL	MCDONNELL-DOUGLAS	RCA
COMMUNICATION RELIABILITY AT MAXIMUM WARNING RANGE	EXCELLENT	EXCELLENT	GOOD
WARNING TIME ACCURACY (R/R INDEX)	BEST	GOOD	GOOD
CAN COMMUNICATE IN 1985 (L.A. BASIN MODEL) WITH ALL AIRCRAFT ACAS EQUIPPED?	YES	YES	NO
INTERFERENCE SUSCEPTIBILITY TO RADAR ALTIMETERS	BEST	WORST	MEDIUM
DEGREE OF DESIGN MATURITY	HIGH	MEDIUM TO HIGH	LOW

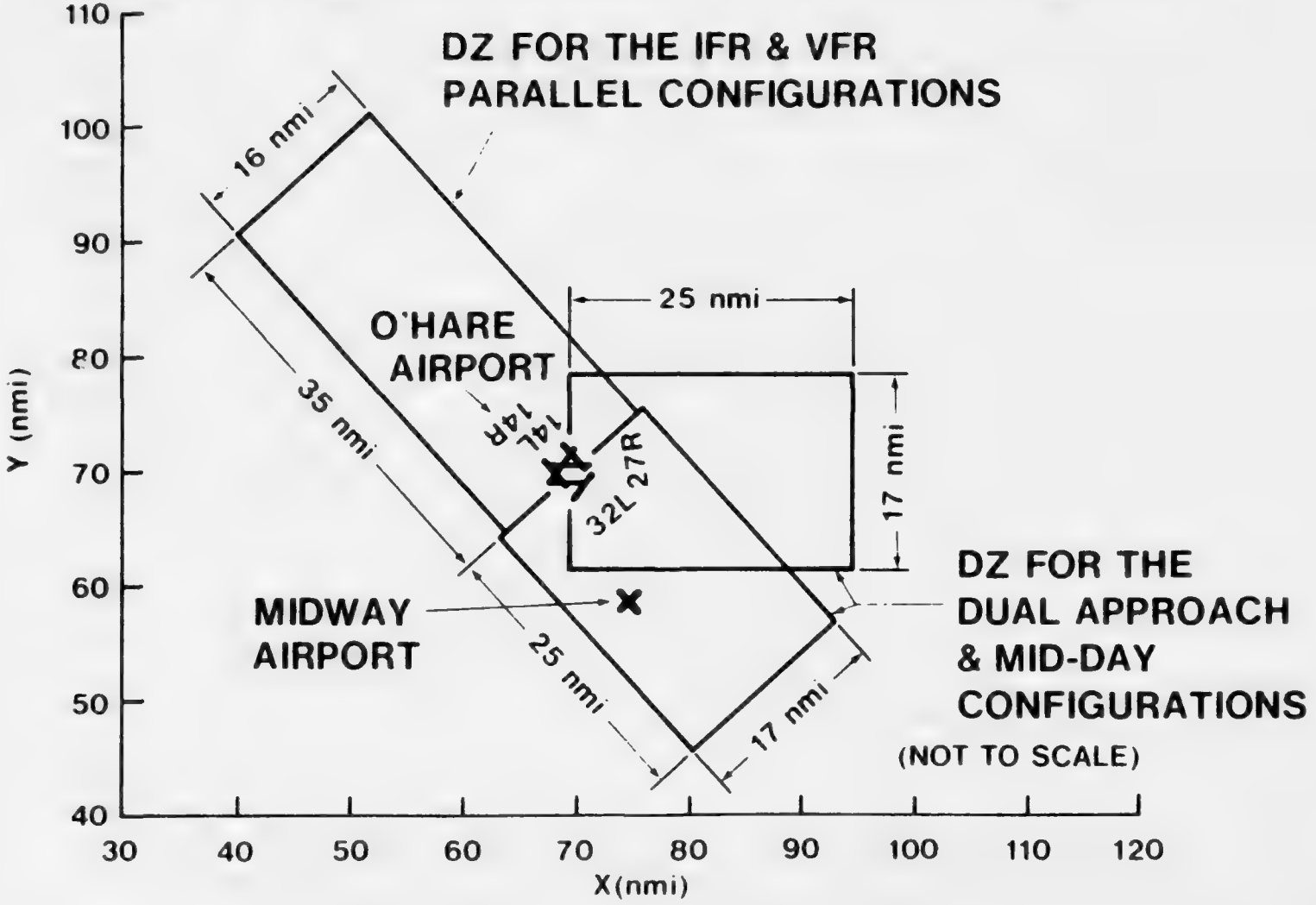
ACAS OPERATIONAL SIMULATIONS

- NUISANCE ALARMS IN TERMINAL AREAS ARE SEVERE
  - ALARM VOLUME IS GREATER THAN ATC VOLUMES
  - REQUIRES DESENSITIZATION (REDUCED PROTECTION)
  - AIRPORT DEPENDENT
  - SHUT-OFF CLOSE TO AIRPORT
- UNPLANNED/UNCOORDINATED MANEUVERS --- CHAIN REACTION IS A CONCERN

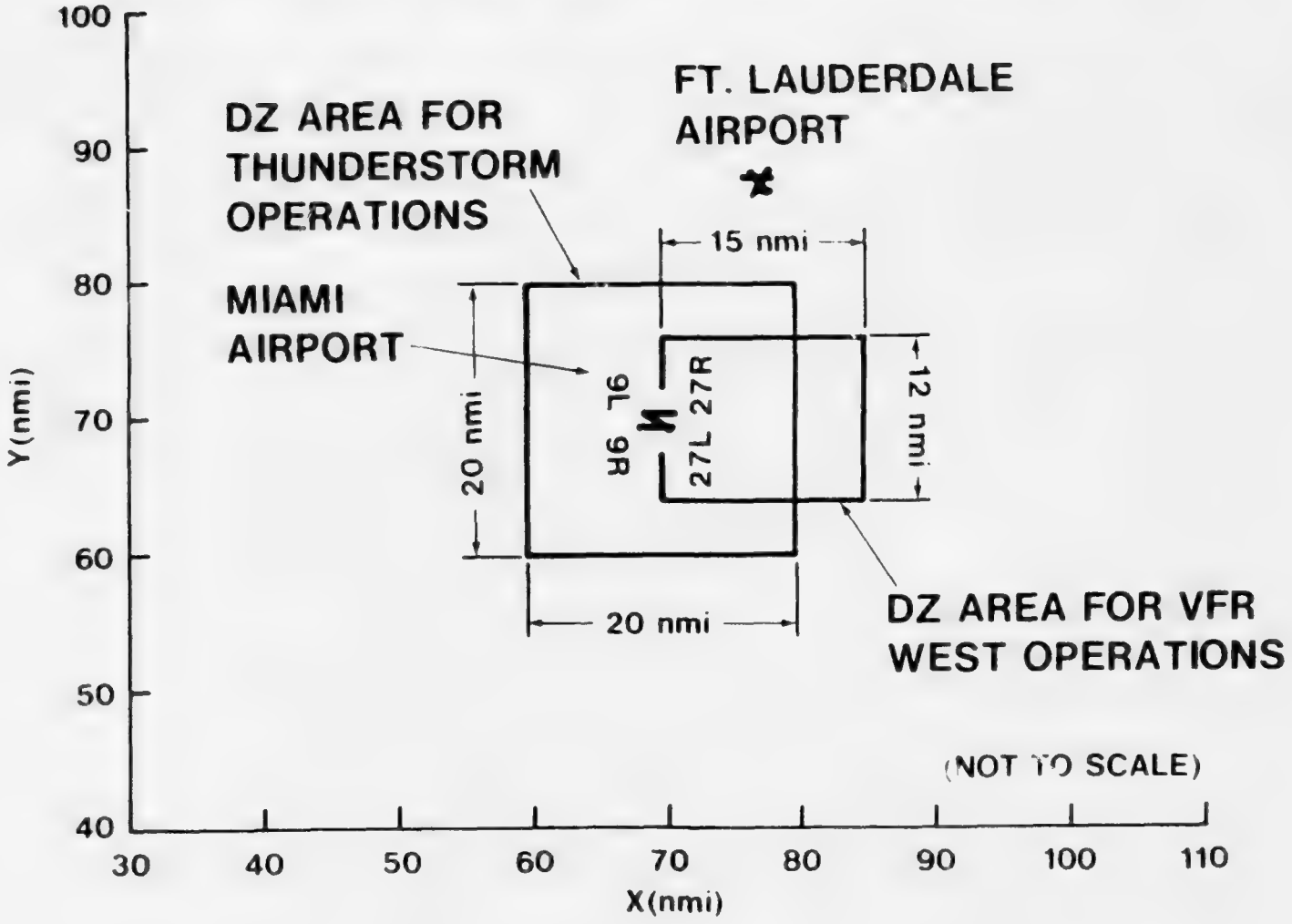
DESENSITIZATION ZONES FOR THE LOS ANGELES ENVIRONMENT



DESENSITIZATION ZONES FOR THE CHICAGO ENVIRONMENT



DESENSITIZATION ZONES FOR THE MIAMI ENVIRONMENT



ACAS COSTING ANALYSIS

- ALL ACAS COSTING WAS DONE BY ARINC RESEARCH CORPORATION
- BOTH AIR CARRIER AND GENERAL AVIATION VERSIONS OF THE THREE COMPETING ACAS SYSTEMS WERE COSTED
- ARINC OBTAINED BOTH THE FINAL DESIGNS AND THE MANUFACTURER'S COST ESTIMATE, AND THEN CRITIQUED AND DEVELOPED THEIR OWN COSTS
- GENERAL AVIATION ELECTRONIC COSTS WERE VERIFIED BY BOTH NARCO AND GENAVE, TWO GENERAL AVIATION ELECTRONICS PRODUCERS
- DOD COSTS WERE VERIFIED BY DOD
- AIR CARRIER INSTALLATION COSTS WERE OBTAINED FROM THE AIRLINES
- GENERAL AVIATION INSTALLATION COSTS WERE OBTAINED FROM A SURVEY OF GENERAL AVIATION REPAIR AND INSTALLATION SHOPS

ACAS AVIONIC COSTS

AIR CARRIER	HONEYWELL	MCDONNELL	RCA
BOX (1)	$4,012	$4,694	$5,501
DISPLAY (2)	1,092	1,092	1,092
CONTROL (1)			127
ANTENNA (2)	63	63	63
TOTAL	$6,322	$7,004	$7,938

NOTES: ( ) INDICATE NUMBER OF UNITS REQUIRED
AND ARE REFLECTED IN BOTTOM TOTAL

ACAS AVIONIC COSTS

GENERAL AVIATION	HONEYWELL		MCDONNELL		RCA	
	WITHOUT ALTITUDE ENCODER	WITH ALTITUDE ENCODER	WITHOUT ALTITUDE ENCODER	WITH ALTITUDE ENCODER	WITHOUT ALTITUDE ENCODER	WITH ALTITUDE ENCODER
BOX WITH DISPLAY (1)	904	1,161	1,584	1,820	1,837	2,073
ANTENNA	13 (2)	13 (2)	13 (1)	13 (1)	13 (1)	13 (1)
TOTAL	$930	$1,186	$1,597	$1,833	$1,850	$2,086

NOTES: ( ) INDICATE NUMBER OF UNITS REQUIRED AND ARE REFLECTED IN BOTTOM TOTAL

GENERAL AVIATION COSTS ARE SELLING PRICE WHICH IS LIST PRICE LESS 20% DISCOUNT

ACAS IMPLEMENTATION ASSUMPTIONS

	TYPE OF AVIONICS*	
CATEGORIES OF AIRCRAFT	AIR CARRIER	GENERAL AVIATION
AIR CARRIER	▲	
LARGE GENERAL AVIATION	▲	
SMALL GENERAL AVIATION		▲
MILITARY HI PERFORMANCE	▲	
MILITARY LO PERFORMANCE		▲

*IN ALL CASES SINGLE SYSTEM INSTALLATION IS ASSUMED

ACAS INSTALLATION COSTS

AIR CARRIER TYPE AIRCRAFT	$4227*
LARGE GENERAL AVIATION AIRCRAFT	$1925
SMALL GENERAL AVIATION AIRCRAFT	$ 226
MILITARY HI PERFORMANCE AIRCRAFT	$8252*
MILITARY LO PERFORMANCE AIRCRAFT	$2479*

* THESE COSTS DO NOT INCLUDE NONRECURRING COSTS UNIQUE TO BOTH DOD AND THE AIRLINES

ACAS MAINTENANCE COSTS

FIGURES ARE COST PER AIRCRAFT PER YEAR BASED ON AIRCRAFT USAGE AND ELECTRONICS RELIABILITY

	HONEYWELL	MCDONNELL-DOUGLAS	RCA
AIR CARRIER	$337	$302	$358
LARGE GENERAL AVIATION AIRCRAFT	$ 22	$ 19	$ 24
SMALL GENERAL AVIATION AIRCRAFT	$ 23	$ 39	$ 32
HI PERFORMANCE DOD	$781	$767	$776
LO PERFORMANCE DOD	$882	$952	$918

ACAS NONRECURRING COSTS*

	HONEYWELL	MCDONNELL	RCA
AIR CARRIER	$103	$160	$164
LARGE GENERAL AVIATION	$ 0	$ 0	$ 0
SMALL GENERAL AVIATION	$ 0	$ 0	$ 0
MILITARY HI PERFORMANCE	$ 391	$ 514	$ 471
MILITARY LO PERFORMANCE	$ 100	$208	$ 196

*DOCUMENTATION COSTS, ONE TIME ENGINEERING COSTS, SPARES, ETC.

ACAS AVIONICS LIFE CYCLE COSTS

AIRCRAFT CATEGORIES FOR SEPARATION ASSURANCE	FLEET SIZE 1985	% EXPECTED TO EQUIP	COST		
			HONEYWELL	MDEC	RCA
PUBLIC AIR TRANSPORTATION	4,900	100	$ 56 M	$ 59 M	$ 65 M
FEDERAL AIR TRANSPORTATION	2,200	100	$ 22 M	$ 24 M	$ 24 M
PRIVATE AIR TRANSPORTATION	6,000	100	$ 49 M	$ 54 M	$ 60 M
OTHER FEDERAL AIRCRAFT	20,000	100	$229 M	$244 M	$ 254 M
OTHER GENERAL AVIATION	189,400	100	$277 M	$ 413 M	$ 459 M
AIRCRAFT WITHOUT AVIONICS	36,500	0	0	0	0
TOTAL	259,000		$633 M	$794 M	$ 862 M

NOTE. THESE COST INCLUDE ELECTRONICS. INSTALLATION. NONRECURRING COSTS. MAINTENANCE COSTS AND THE COST OF AN ENCODER

ACAS GROUND COSTS

- OPERATION OF THE MCDONNELL-DOUGLAS SYSTEM WILL REQUIRE THE OPERATION OF 5 GROUND SYNCHRONIZING STATIONS, AT AN INVESTMENT COST OF ABOUT $1.5M AND A YEARLY OPERATIONS/MAINTENANCE COST (NOT ESTIMATED)
- NEITHER THE HONEYWELL OR RCA SYSTEMS REQUIRE GROUND STATIONS

ADDITIONAL COST

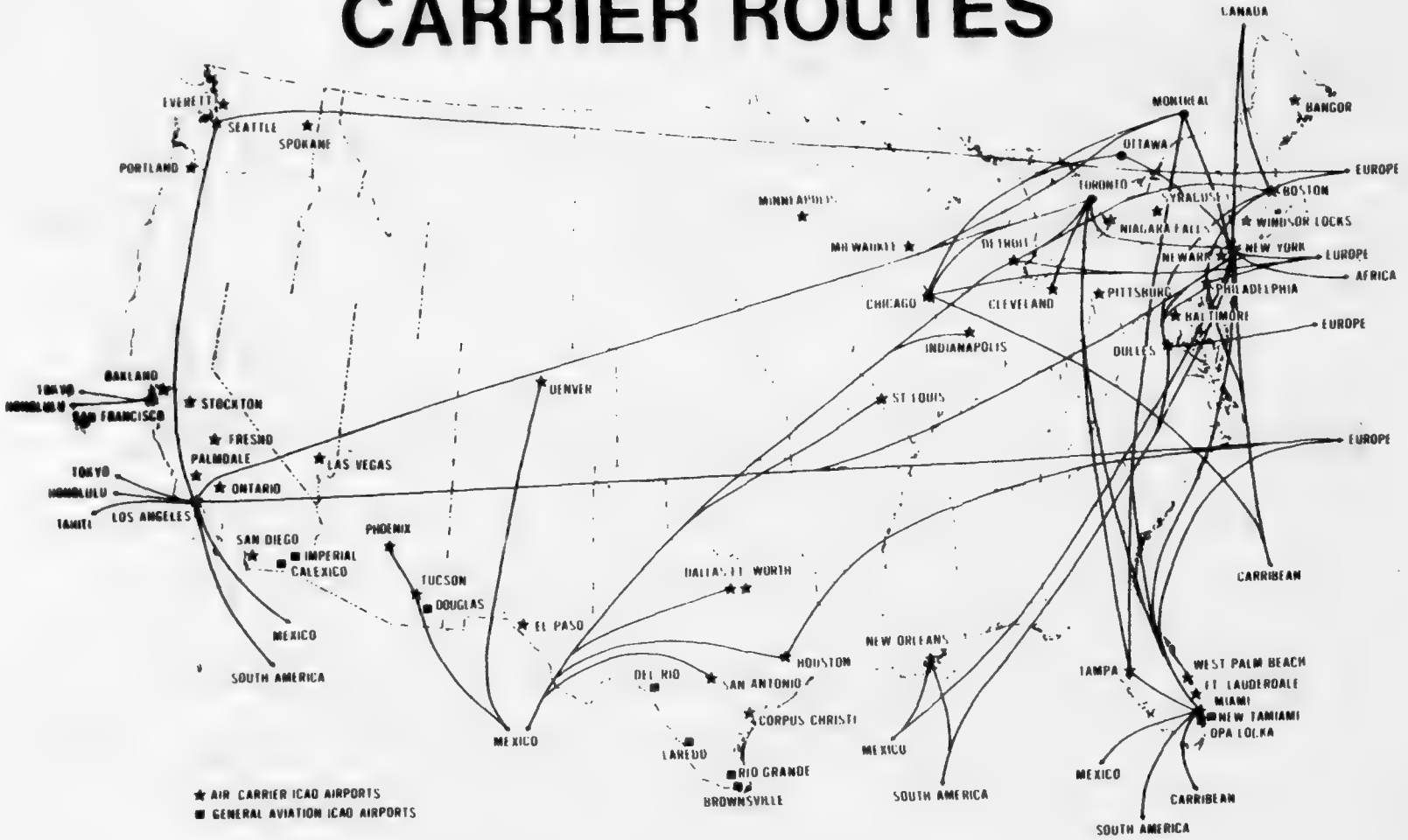
RADAR ALTIMETER INTERFERENCE

- RADAR ALTIMETERS OPERATE ON THE SAME FREQUENCY AS ACAS
- TESTS TO DATE INDICATE THAT RADAR ALTIMETERS DO INTERFERE WITH THE ACAS EQUIPMENTS TESTED
- VULNERABILITY TO INTERFERENCE IS LEAST WITH HONEYWELL AND HIGHEST WITH McDONNELL-DOUGLAS
- THE BONZER TRN-70 RADAR ALTIMETER IS THE WORST OFFENDER AND THE MOST NUMEROUS GENERAL AVIATION TYPE
- TESTS SHOW EXCESSIVE INTERFERENCE BETWEEN RADAR ALTIMETERS AND ACAS ON THE SAME AIRFRAME
- RETUNING OF RADAR ALTIMETERS TO THE PREVENT/REDUCE INTERFERENCE APPEARS IMPRACTICAL
- FAA RECOMMENDS EXCLUSION OF RADAR ALTIMETERS FROM THE ACAS FREQUENCY BAND AT THE COST OF $85 MILLION TO DOD AND $1 MILLION TO GENERAL AVIATION

INTERNATIONAL CONCERNS

- IF IMPLEMENTATION LEFT OPTIONAL FOR INTERNATIONAL TRAFFIC, NO PROTECTION IS GIVEN TO OR OBTAINED FROM THOSE AIRCRAFT WHICH DO NOT EQUIP
- MANDATORY IMPLEMENTATION REQUIRES ICAO ADOPTION --- DIFFICULT AND TIME CONSUMING

INTERNATIONAL AIR CARRIER ROUTES



ACAS ASSESSMENT

- MINNEAPOLIS-HONEYWELL IS CLEARLY BEST ACAS SYSTEM AVAILABLE
- GOOD SERVICE OUTSIDE OF TERMINAL AREAS PROTECTION LIMITED IN TERMINAL REGIONS
- FULL PROTECTION REQUIRES MANDATORY IMPLEMENTATION - $719 M
- INTERNATIONAL PROTECTION IS DIFFICULT

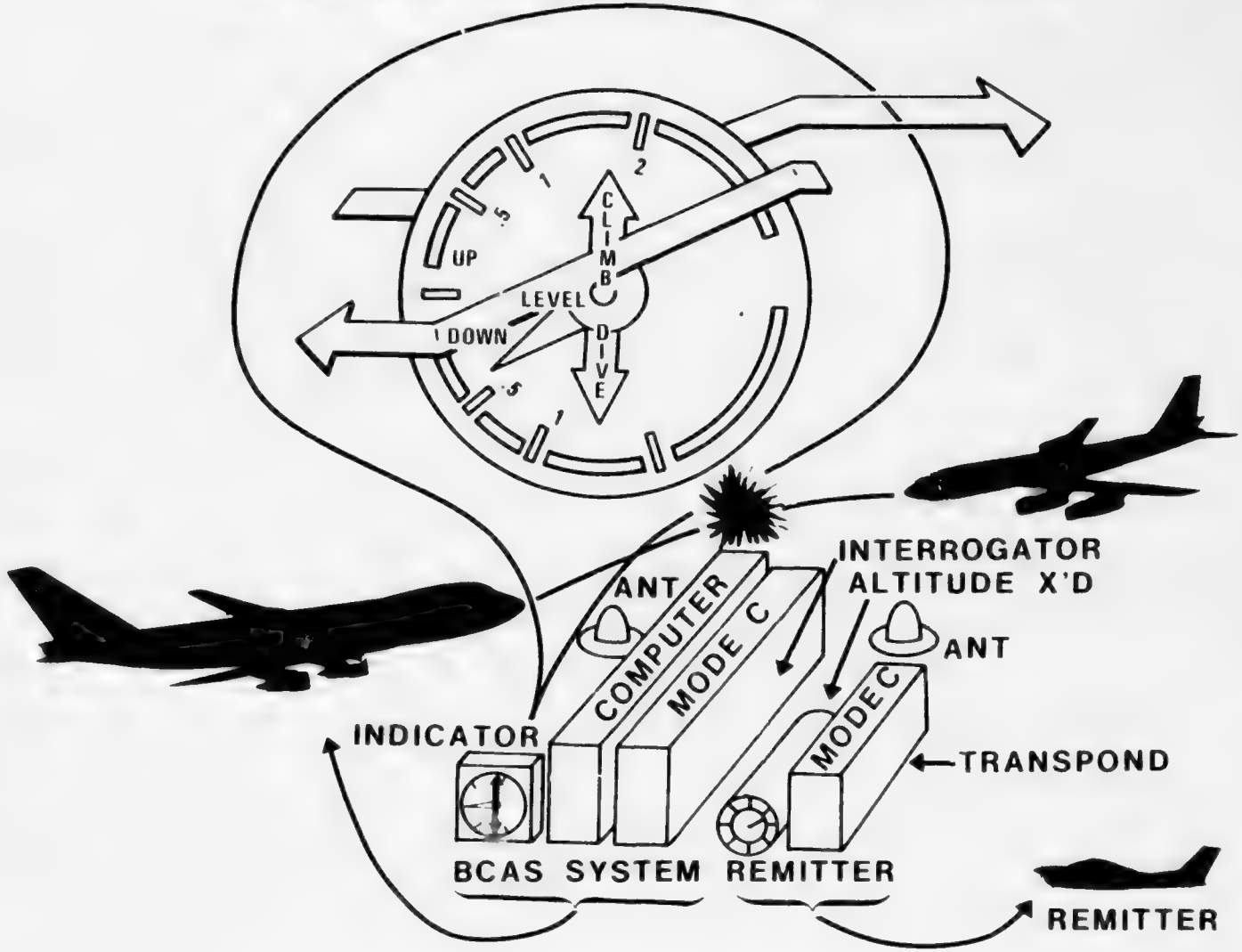
BCAS

AN ACAS UTILIZING THE ATCRBS OR DABS BEACON TRANSPONDER, WITH ALTITUDE ENCODING, AND ASSOCIATED SIGNAL STRUCTURE

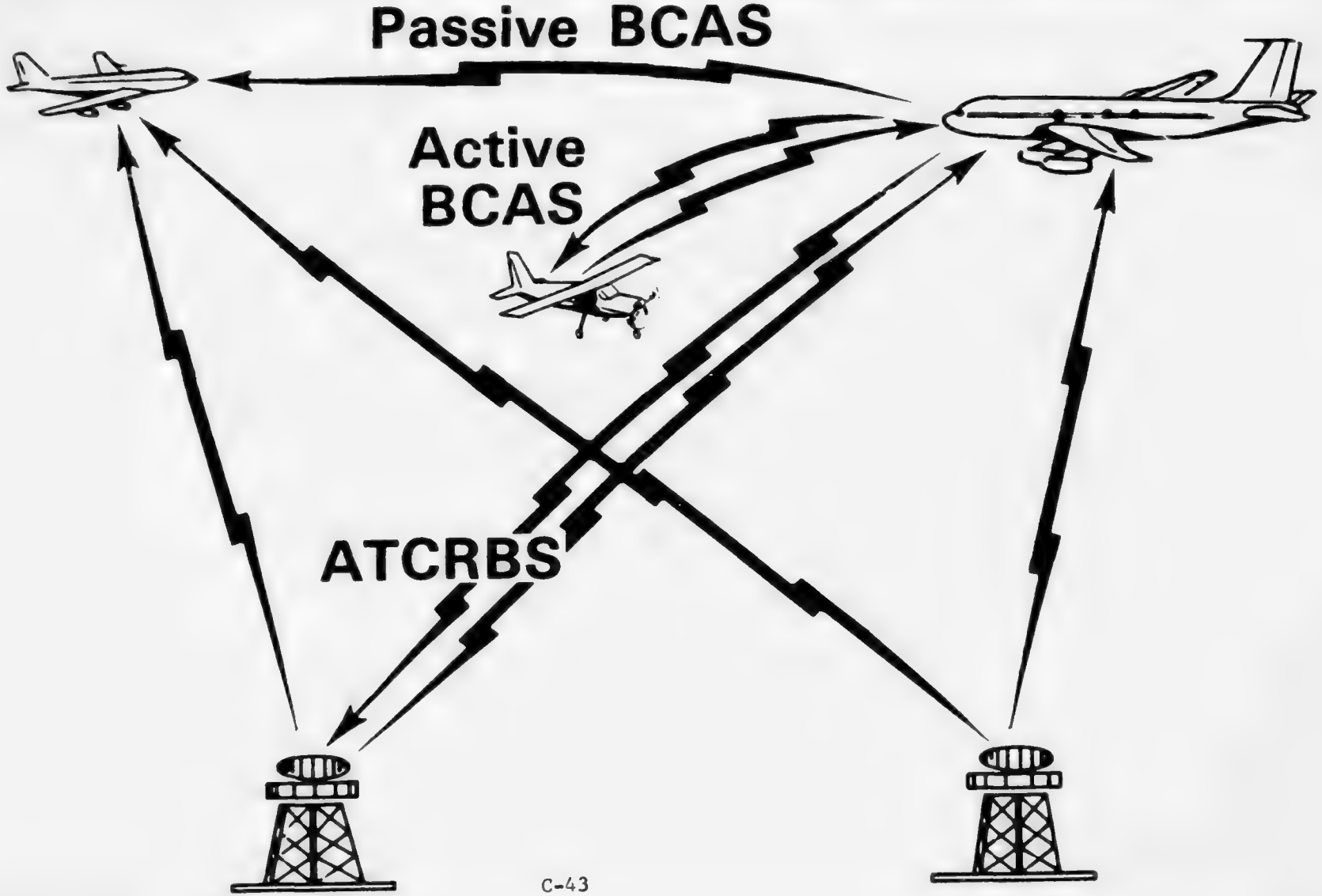
BCAS

- BCAS EQUIPPED AIRCRAFT PROTECTED AGAINST ALL AIRCRAFT WITH TRANSPONDERS AND ENCODING ALTIMETERS
- FIRST AIRCRAFT EQUIPPED HAS IMMEDIATE HIGH LEVEL PROTECTION
- ONLY THOSE DESIRING ADDITIONAL PROTECTION NEED BUY THE EQUIPMENT
- ECONOMIC AND REGULATORY

BCAS DESCRIPTION



BCAS Concept



BCAS SYSTEM

ACTIVE MODE

- VERTICAL MANEUVERS
- SERVICE OUTSIDE SURVEILLANCE

PASSIVE MODE

- HORIZONTAL AND VERTICAL MANEUVERS
- PWI
- SERVICE UNDER MULTIPLE RADAR COVERAGE

DUAL MODE

- COMBINES ACTIVE AND PASSIVE MODES
- SERVICE UNDER SINGLE RADAR COVERAGE

BCAS HISTORY

1968	G. LITCHFORD PROPOSED A PWI UTILIZING ATCRBS
1972	USAF AWARDED CONTRACT TO LITCHFORD TO DEMONSTRATE CONCEPT FEASIBILITY OF SSR -- CAS TECHNIQUE
1973	SSR -- CAS DEMONSTRATED ON GROUND AT LAGUARDIA, N.Y. AIRPORT. FAA SUGGESTED THAT AN ACTIVE MODE BE ADDED TO SSR -- CAS
1974	SSR -- CAS DEMONSTRATED ON PAN AM BUILDING, N.Y. CITY FAA CONDUCTED TECHNICAL ANALYSIS OF SSR -- CAS FAA DEVELOPED CONCEPT OF PURELY ACTIVE BCAS
1975	FAA PROCEEDED TO DEVELOP ACTIVE BCAS
	CONTRACT AWARDED TO LITCHFORD FOR DELIVERY OF HIS ACTIVE/PASSIVE (SSR -- CAS) BCAS SYSTEM

BCAS STATUS

- CONCEPT FEASIBILITY OF BOTH PASSIVE/ACTIVE AND ACTIVE SYSTEM DEMONSTRATED
- DEVELOPMENT PROGRAM UNDERWAY
- FEASIBILITY MODELS OF BOTH ACTIVE AND PASSIVE/ACTIVE PRESENTLY FLYING AT NAFEC
- DRAFT ENGINEERING REQUIREMENT AVAILABLE FOR BOTH ACTIVE AND PASSIVE/ACTIVE SYSTEM
- REQUEST FOR PROPOSAL FOR PROTOTYPES PLANNED FOR MARCH 77

COMPARISON OF ACAS & BCAS

	ACAS	BCAS
1. LIMITATIONS	DENSE TERMINAL AREAS	DENSE TERMINAL AREAS
2. SERVICE AREAS	CONUS	WORLDWIDE
3. INFORMATION AVAILABLE TO SYSTEM	RANGE AND ALTITUDE	RANGE, ALTITUDE, BEARING (PASSIVE MODE)
4. MANEUVER COMMANDS	CLIMB/DIVE	CLIMB/DIVE AND TURNS

ACAS/BCAS - LIMITATIONS

PROBLEM - EXCESSIVE ALARMS IN HIGH DENSITY TERMINAL AREAS

STUDIES:

1. NAFEC SIMULATION CHICAGO O'HARE PARALLEL RUNWAY CONFIGURATION
2. NAFEC STUDY UTILIZING ARTS III TAPES OF O'HARE, LOS ANGELES, MIAMI AND WASHINGTON

CONCLUSIONS:

1. THE PRESENT ESCAPE LOGIC (ANTC-117) PRODUCES EXCESSIVE UNNEEDED ALARMS AROUND HIGH DENSITY AIRPORTS
2. SECONDARY ATC COMMANDS ARE INCREASED DUE TO UNWANTED OR NEEDED CAS COMMANDS
3. LOGIC MUST BE MODIFIED FOR TERMINAL AREA OPERATION (DESENSITIZED)
4. NEITHER ACAS OR BCAS WILL WORK IN TERMINAL AREA

COMPARISON OF ACAS & BCAS

	ACAS	BCAS
5. COOPERATIVE ELEMENT (PLUS ENCODER)	ACAS	ATCRBS/DABS TRANSPONDER
6. REGULATORY ASPECTS (PUBLIC PASSENGER PROTECTION)	MANDATORY	MANDATORY/ VOLUNTARY
7. STATUS	T&E COMPLETE	DEVELOP-MENTAL

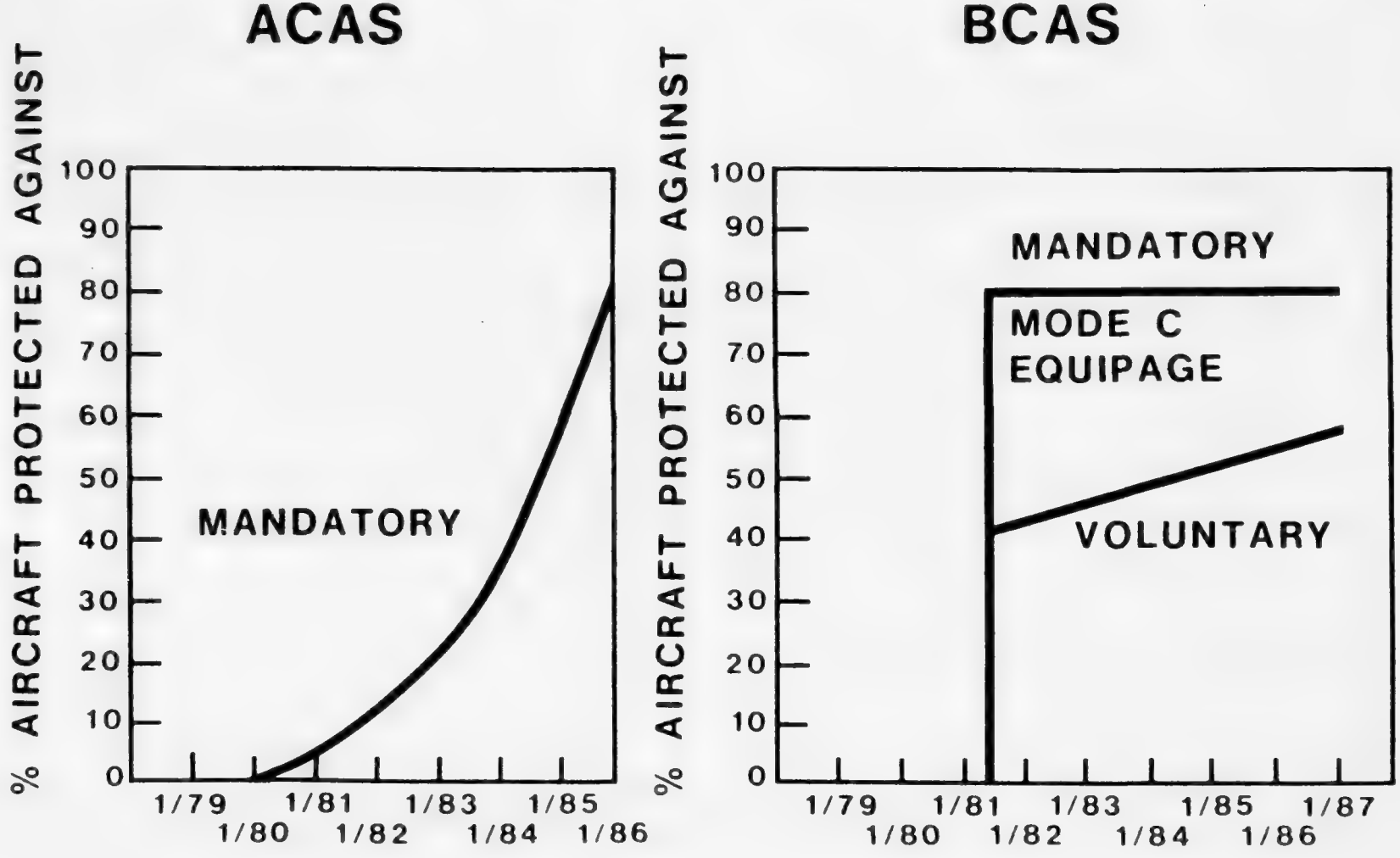
COMPARISON OF ACAS & BCAS

	ACAS	BCAS
8. AVAILABILITY		
AVIONICS	1/80	6/81
GROUND	NONE REQUIRED	NONE REQUIRED
9. WHEN PROTECTION ACHIEVED	MID 1980's	MID 1980's
10. UNIT COSTS (ELECTRONICS)		
AIR CARRIER	$6,300	$18,300
GENERAL AVIATION	$930	
11. COST FOR PUBLIC PASSENGER PROTECTION	$719M	$307M

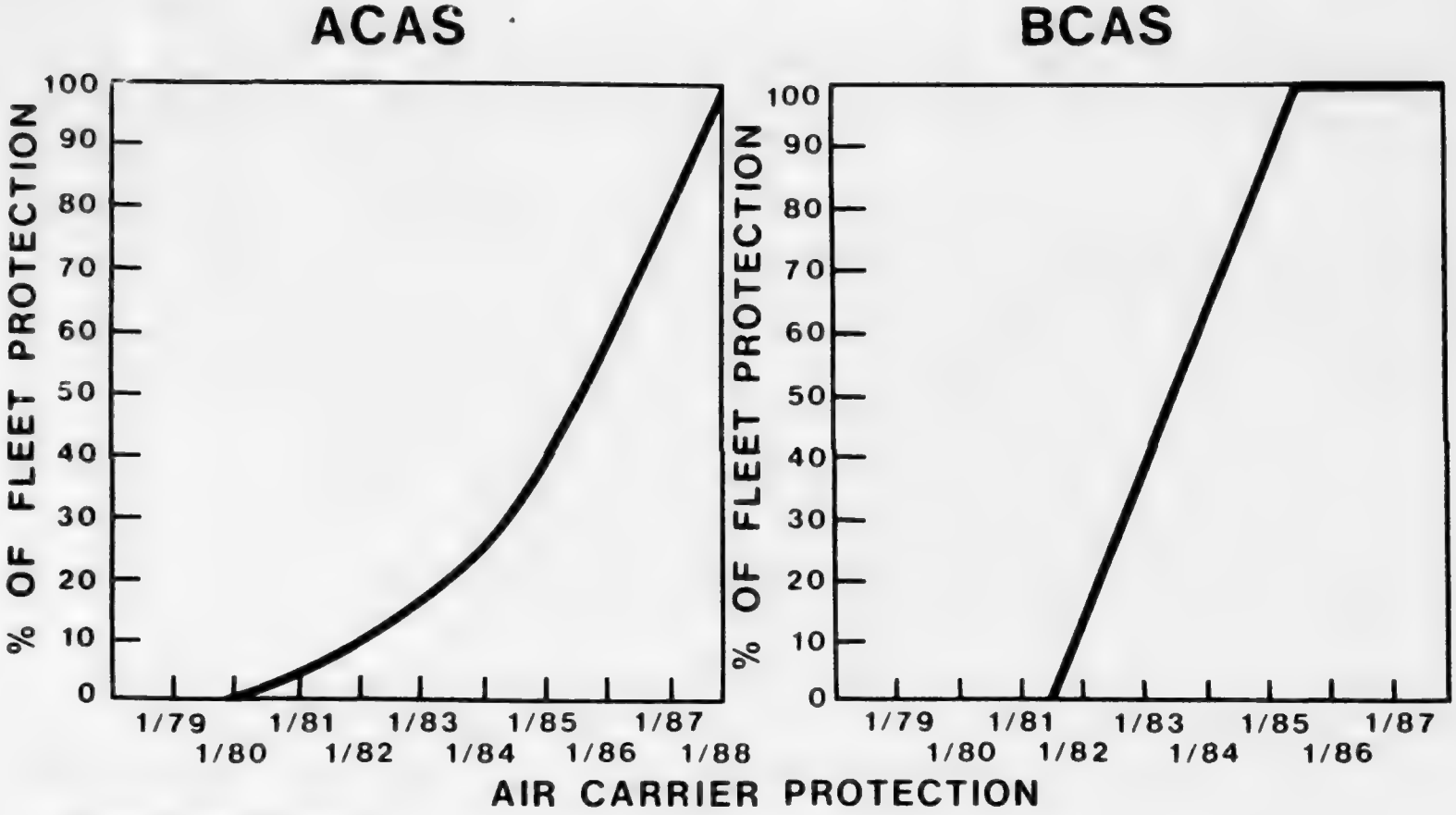
AVAILABILITY

AVIONICS	ACAS	BCAS
LOGIC REFINEMENT	6/77	10/78
NATIONAL STANDARD	1/78	1/80
AVIONICS STANDARDS AND RULEMAKING	1/79	6/80
FIRST UNIT AVAILABLE FOR INSTALLATION	1/80	6/81

ACAS VS. BCAS PROTECTION



ACAS VS. BCAS PROTECTION



ASSUMPTIONS

4 YEARS TO EQUIP AIR TRANSPORTATION

8 YEARS TO EQUIP GENERAL AVIATION AND MILITARY

COSTING ANALYSIS

- INITIAL COSTING WAS ACCOMPLISHED BY COLLINS RADIO
  - COSTS WERE DEVELOPED FOR AN AIR CARRIER TYPE VERSION ONLY
  - COSTS WERE BASED ON FUNCTIONAL DESIGNS COMPARED TO HARDWARE DESIGNS FOR ACAS AND DABS/IPC
  - PRESENT PRELIMINARY DESIGNS WERE USED
  - NO CUSTOM LSI TECHNOLOGY ASSUMED (USED FOR ACAS)
  - COMPARED TO ACAS, COSTS SEEM HIGH BY A FACTOR OF TWO
- FOR ABOVE REASONS INITIAL COLLINS COSTING NOT UTILIZED
- COSTING TECHNIQUE USED
  - 3 TIMES THE COST OF HONEYWELL ACAS FOR ACTIVE
  - 4 TIMES THE COST OF HONEYWELL ACAS FOR PASSIVE/ACTIVE

BCAS AVIONICS COSTS

AIR CARRIER	ACTIVE	PASSIVE/ ACTIVE
BOX (1)	12,036	16,048
DISPLAY (2)	1,092	1,092
ANTENNA (2)	63	63
TOTALS	14,346	18,358

NOTE: ( ) INDICATE NUMBER OF UNITS REQUIRED AND ARE REFLECTED IN BOTTOM TOTAL

AD-A032 354 FEDERAL AVIATION ADMINISTRATION WASHINGTON D C ASSOC--ETC F/G 1/3
CONSULTATIVE PLANNING CONFERENCE ON AIRCRAFT SEPARATION ASSURAN--ETC(U)
SEP 76

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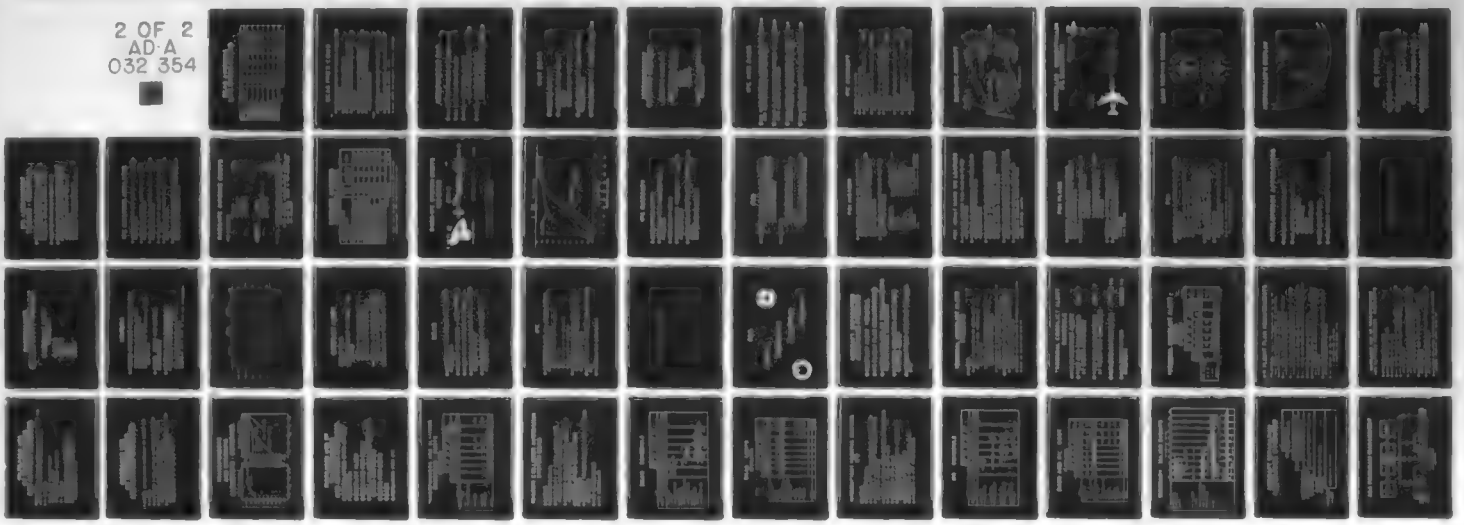

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BCAS AVIONICS
LIFE CYCLE COSTS

AIRCRAFT CATEGORIES FOR SEPARATION ASSURANCE	FLEET SIZE 1985	% EXPECTED TO EQUIPT	COST	
			ACTIVE	PASS./ACT.
PUBLIC AIR TRANSPORTATION	4,900	100	$ 94 M	$113 M
FEDERAL AIR TRANSPORTATION	2,200	100	$ 43 M	$ 52 M
PRIVATE AIR TRANSPORTATION	6,000	100	$111 M	$142 M
OTHER FEDERAL AIRCRAFT	20,000	0	0	0
OTHER GENERAL AVIATION	189,400	0	0	0
AIRCRAFT WITHOUT AVIONICS	36,500	0	0	0
TOTAL	259,000		$248 M	$307M

BCAS PRO'S/CON'S

PRO

- COOPERATIVE ELEMENT IS A NORMAL TRANSPONDER AND ENCODER
- FEWER INTERNATIONAL PROBLEMS
- ONLY THOSE DESIRING PROTECTION NEED BUY IT
- AIRCRAFT EQUIPPED WITH BCAS OBTAIN IMMEDIATE PROTECTION
- INDEPENDENT OF GROUND SYSTEM FAILURE
- BUILDS ON EXISTING AND PLANNED (DABS) SYSTEM
- PROVIDES PROTECTION BOTH INSIDE AND OUTSIDE GROUND SURVEILLANCE

CON

- REQUIRES HIGH EQUIPAGE OF TRANSPONDERS AND ENCODERS
- LIMITATIONS IN TERMINAL AREA (ACAS OR BCAS)
- DEVELOPMENTAL STATUS -- RISK
- COST LIMITS APPLICABILITY (GENERAL AVIATION)

INDEPENDENT CAS

- ALL SYSTEMS LIMITED IN DENSE AREAS
- ALL SYSTEMS COOPERATIVE
- ACAS -- HONEYWELL IS BEST
  -- TEST AND EVALUATION COMPLETE
- BCAS -- UNDER DEVELOPMENT
  TECHNICAL RISK BELIEVED MODEST

WHY BCAS

- BROADER COVERAGE
- LESS REGULATORY IMPACT
  - COST
  - MANDATORY VS VOLUNTARY
- LONG TERM UTILITY DERIVED FROM TRANSPONDERS
- DEVELOPMENT RISK JUDGED REASONABLE

INTERMITTENT POSITIVE CONTROL

- GROUND BASED CAS
- PROTECTION FOR ALL CLASSES OF USERS
  - IFR/IFR
  - IFR/VFR
  - VFR/VFR
- DATA LINK ALLOWS ATC COORDINATION

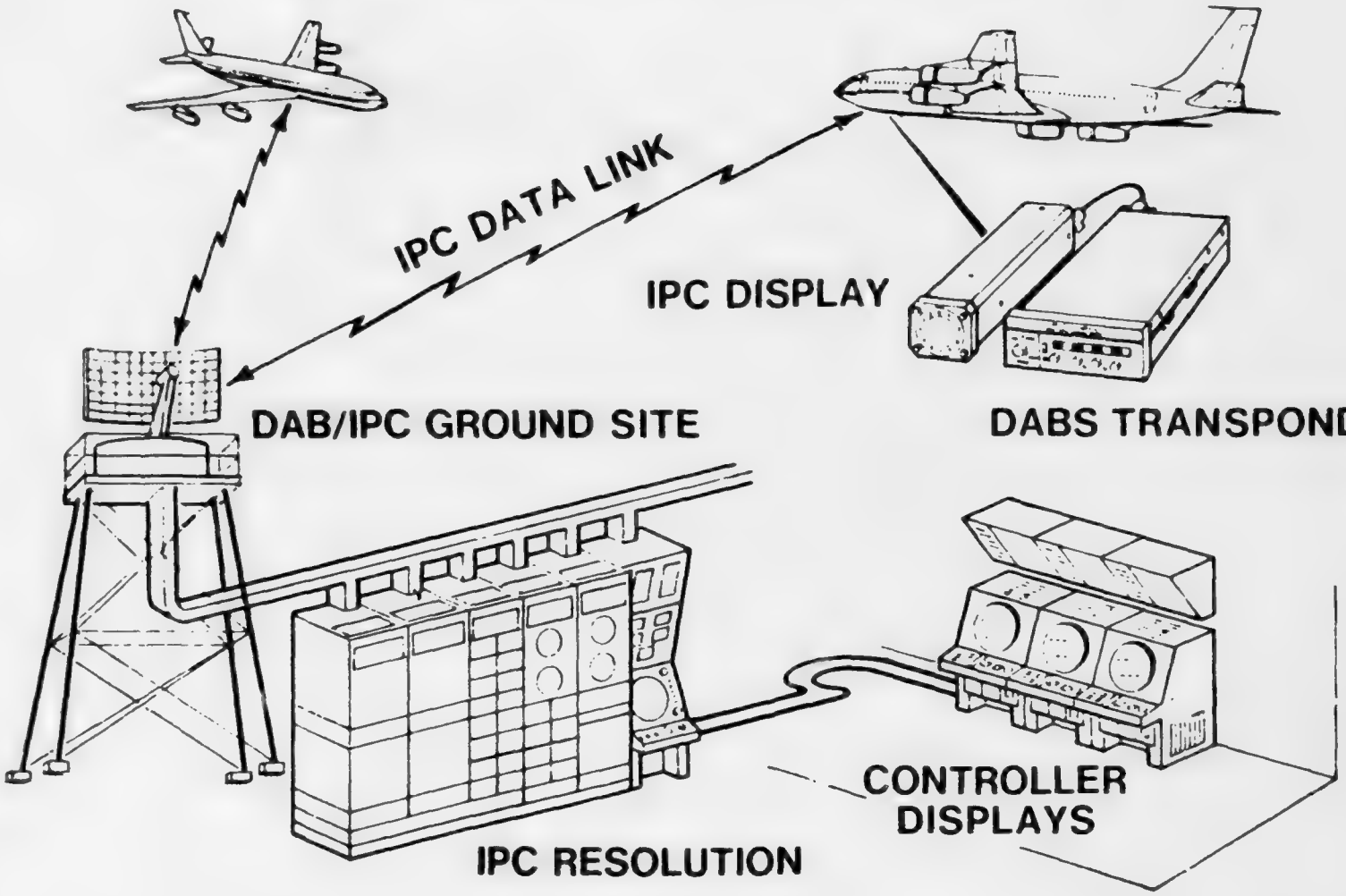
IPC AND DABS

- IPC USES DISCRETE ADDRESS BEACON SYSTEM FOR SURVEILLANCE AND DATA LINK
- DABS IS AN UPGRADED ATCRBS TRANSPONDER WITH BUILT-IN DATA LINK
- EVOLUTIONARY UPGRADING OF ATCRBS FULLY COMPATIBLE WITH TODAY'S SYSTEM
- REQUIRED FOR IMPROVED SURVEILLANCE AND ATC EVOLUTION

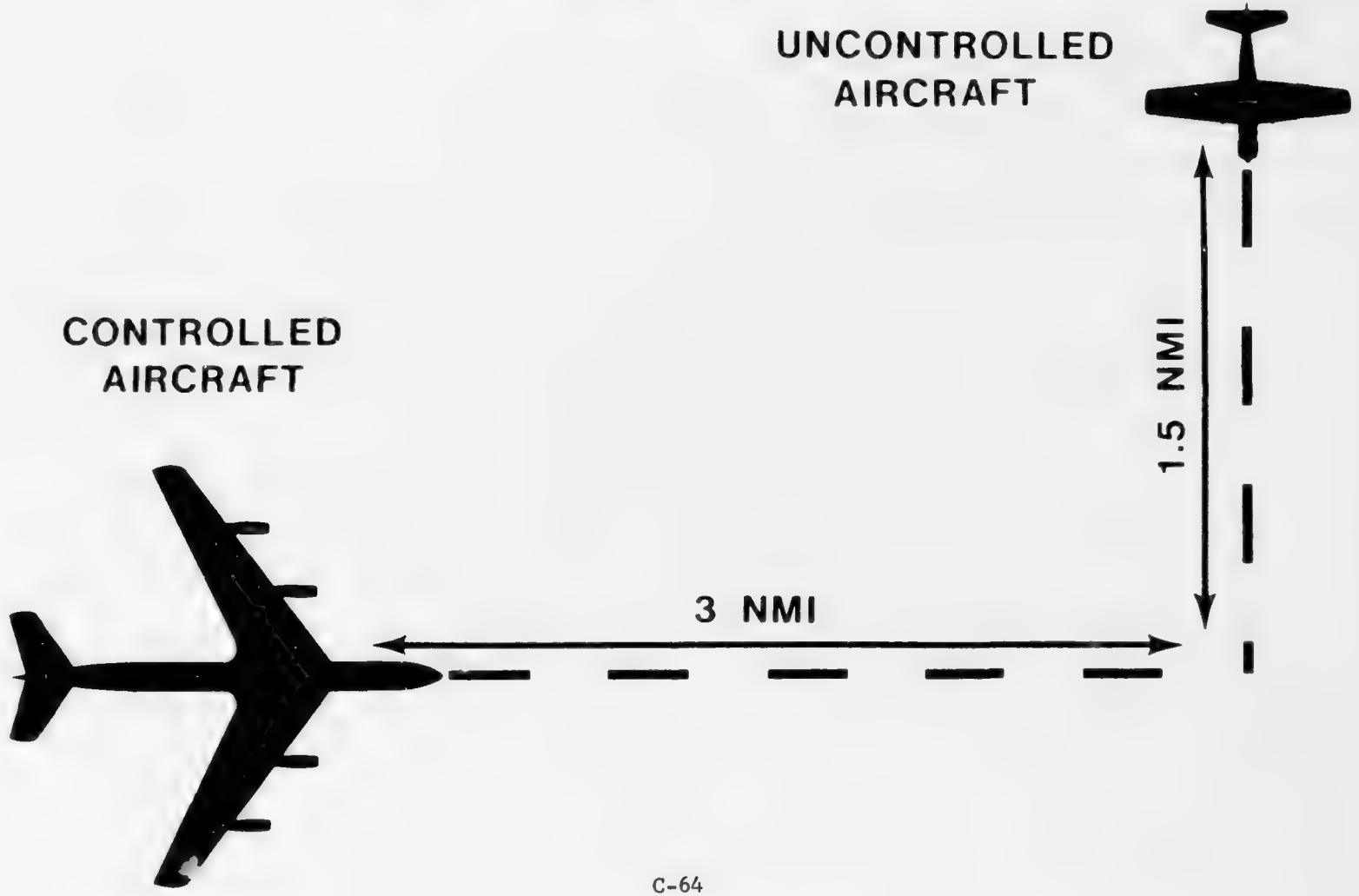
IPC CONCEPT

- GROUND BASED SYSTEM
- REQUIRES DABS DATA LINK
- PROVIDES AUTOMATIC ADVISORIES AND COLLISION AVOIDANCE COMMANDS
- PROVIDES VERTICAL AND HORIZONTAL MANEUVER COMMANDS
- INDEPENDENT OF ATC COMPUTER SYSTEM
- PROVIDES SEPARATION SERVICES TO ALL DABS/IPC AIRCRAFT FROM BOTH DABS AND ATCRBS EQUIPPED AIRCRAFT
- REQUIRES TRANSPONDERS (DABS OR ATCRBS) AND ENCODERS
- COMPUTER PROGRAM ADAPTABLE TO LOCATION AND ATC PROCEDURES
- PROVIDES AUTOMATIC SERVICES TO BOTH VFR AND IFR AIRCRAFT

DABS/IPC CONCEPT

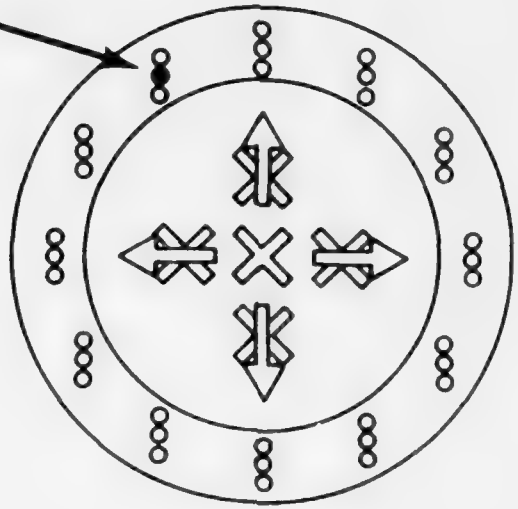


CONTROLLED - UNCONTROLLED IPC ENCOUNTER

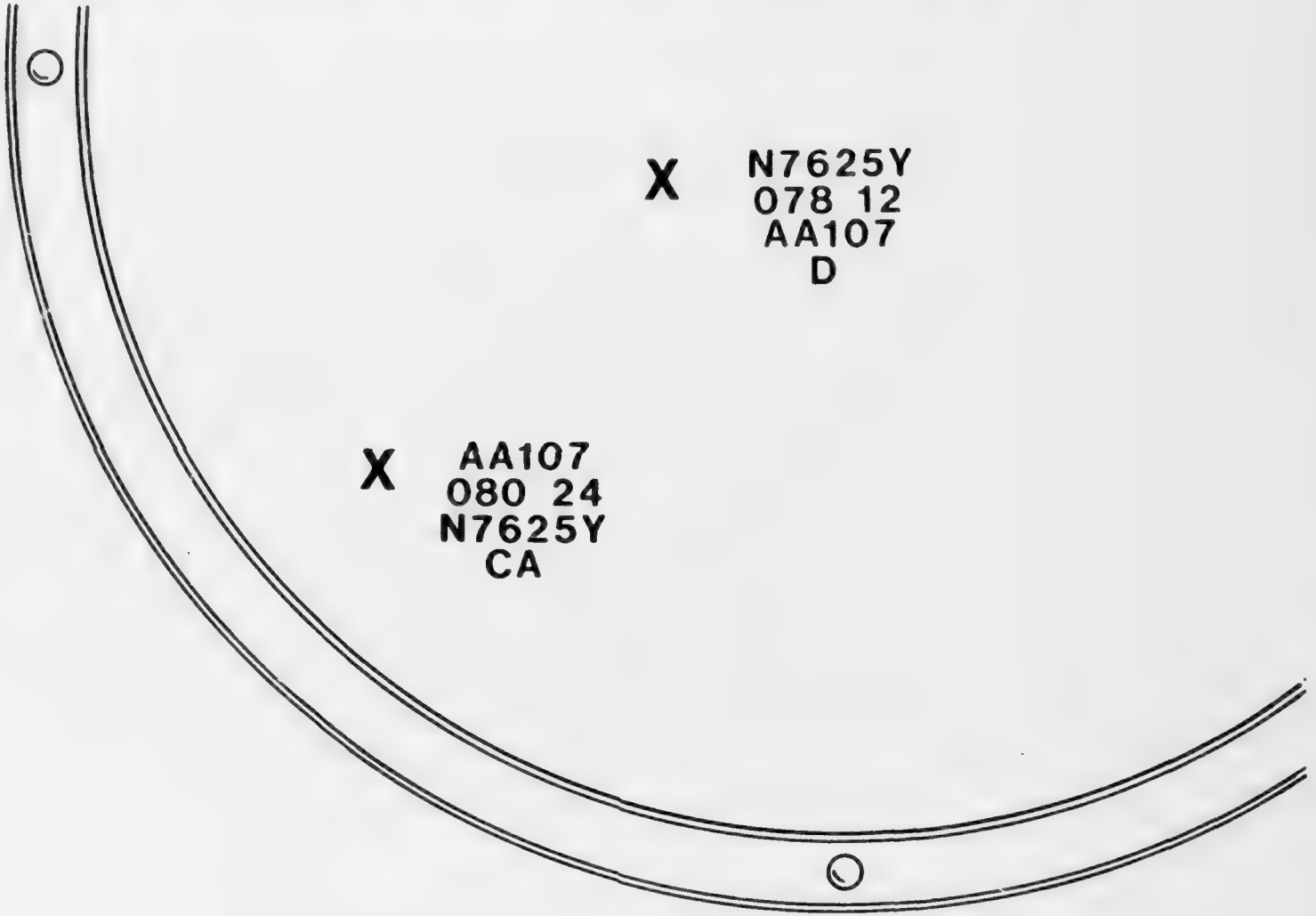


LEAD TIME=45 SECONDS

FLASHING LIGHT
PLUS TONE



CONTROLLER'S DISPLAY



IPC STATUS

- FEASIBILITY VERIFIED
- DEVELOPMENT PROGRAM UNDERWAY
  - FLIGHT TESTING AT LINCOLN LABORATORY
  - FOCUS ON TERMINAL AREAS
- ENGINEERING MODELS FOR NAFEC TEST AND EVALUATION UNDER DEVELOPMENT

IPC ASSESSMENT TO DATE - TECHNICAL

- PROTECTION AGAINST ALL DABS OR ATCRBS EQUIPPED AIRCRAFT (SIMILAR TO BCAS). IFR/IFR, IFR/VFR, VFR/VFR
- ALLOWS VOLUNTARY EQUIPPAGE
- ONLY COMPATIBLE SYSTEM WITH THE POTENTIAL FOR HIGH DENSITY SERVICE
  - CONTROLLER COORDINATION AND BACK-UP
  - PILOT BACK-UP
  - ADAPTABLE TO DIFFERENT AIRPORTS
  - ADAPTABLE TO CHANGES IN ATC PROCEDURES

IPC COSTING ANALYSIS

- AVIONICS COSTING WAS DONE BY ARINC RESEARCH CORPORATION
- AIR CARRIER, GENERAL AVIATION AND MILITARY VERSIONS WERE COSTED
- ARINC COSTS WERE VERIFIED BY BENDIX AVIONICS FOR REASONABLENESS
- LATEST STATE OF THE ART EMPLOYED IN DESIGN
- AIR CARRIER INSTALLATION COSTS WERE OBTAINED FROM THE AIRLINES
- GENERAL AVIATION INSTALLATION COSTS WERE OBTAINED FROM A SURVEY OF GENERAL AVIATION REPAIR AND INSTALLATION SHOPS

DABS/IPC AVIONIC COSTS

AIR CARRIER

BOX (1)	4,860
DISPLAY (2)	1,066
CONTROL (1)	516
ANTENNA (1)	63
	$7,571

GENERAL AVIATION

BOX WITH DISPLAY (1)	986
ANTENNA (1)	13
	$ 999

NOTES: ( ) INDICATE NUMBER OF UNITS REQUIRED AND ARE REFLECTED IN BOTTOM TOTAL

- THE GENERAL AVIATION COSTS SHOWN ARE SELLING PRICE WHICH IS LIST PRICE LESS 20% DISCOUNT

DABS/IPC AVIONICS LIFE CYCLE COSTS

AIRCRAFT CATEGORIES FOR SEPARATION ASSURANCE	FLEET SIZE 1985	% EXPECTED TO EQUIP	COST
PUBLIC AIR TRANSPORTATION	4,900	100	$ 63M
FEDERAL AIR TRANSPORTATION	2,200	100	$ 22M
PRIVATE AIR TRANSPORTATION	6,000	100	$ 60M
OTHER FEDERAL AIRCRAFT	20,000	100	$191M
OTHER GENERAL AVIATION	189,400	100	$235M
AIRCRAFT WITHOUT AVIONICS	36,500	0	0
TOTAL	259,000		$571M

NOTE: THESE COSTS INCLUDE ELECTRONICS, INSTALLATION, NONRECURRING COSTS AND MAINTENANCE COSTS

DABS/IPC SYSTEM COSTS
150 SITES

$ 75 M

GROUND COSTS *

+

$571 M

AVIONICS COST **

=

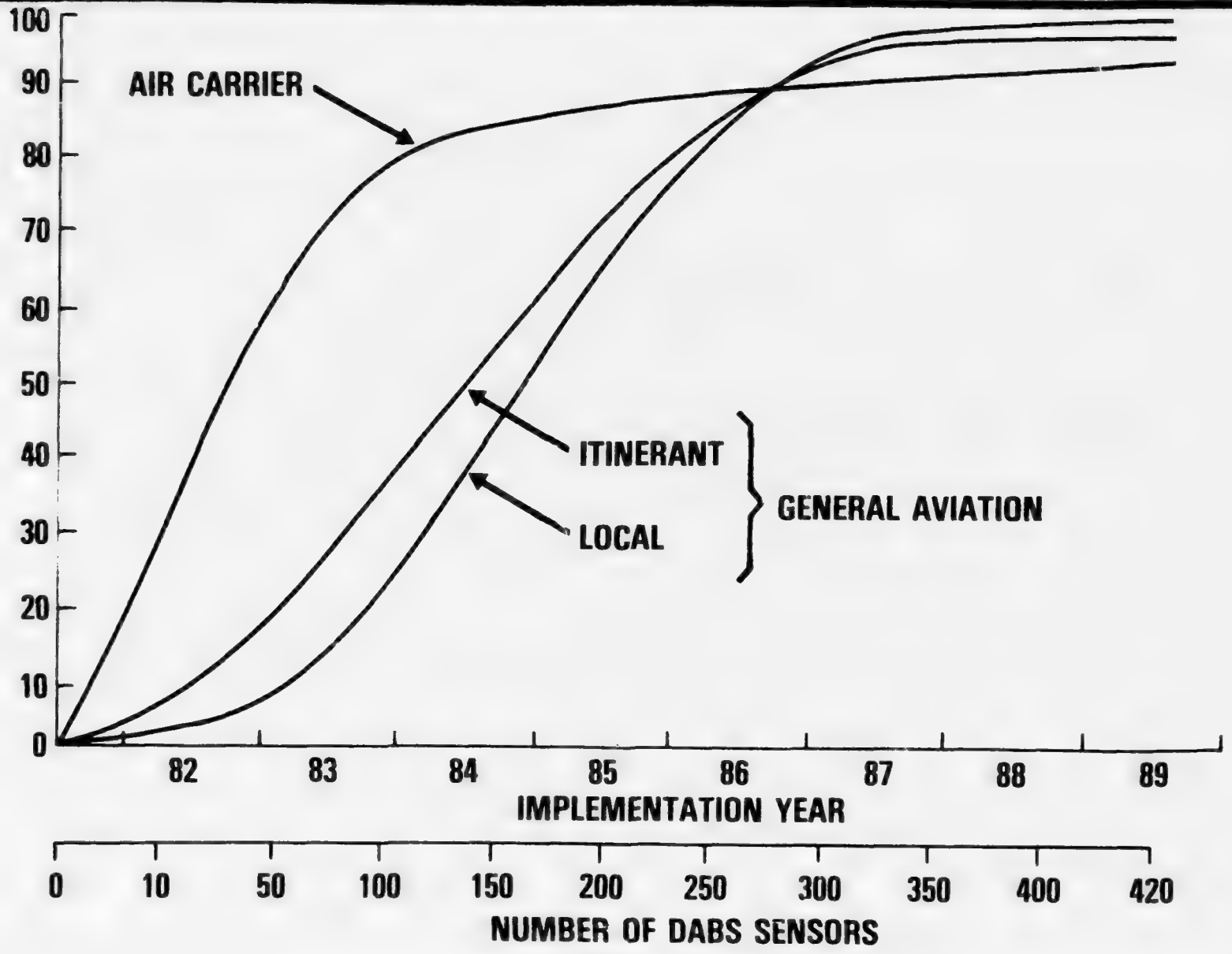
$646 M

TOTAL

* ELECTRONICS PLUS INSTALLATION ONLY

** LIFE CYCLE COSTS THROUGH 1985

V. IPC - Coverage



IPC SUMMARY

- DEVELOPMENT STATUS
- BEST LONG TERM PERFORMANCE POTENTIAL
- HIGH DENSITY AREAS
- EVOLUTIONARY - VOLUNTARY AT MODEST AVIONICS COST
- COVERAGE LIMITED TO DABS SURVEILLANCE AREAS.
  SUPPLEMENTED BY BCAS

PWI

DEFINITION: PROVIDES PILOT WITH WARNING INFORMATION ON NEARBY AIRCRAFT, BUT DOES NOT PROVIDE AUTOMATIC AVOIDANCE COMMAND

IMPLICATIONS

- PILOT MUST VISUALLY ACQUIRE OTHER AIRCRAFT AND DECIDE WHAT TO DO
- PWI IS USEFUL ONLY IN VFR WEATHER AND AT VISUAL DETECTION RANGES

PWI HISTORY

- FAA TESTS BEGAN IN 1967 AND INCLUDED BENCH MEASUREMENT OF TECHNICAL CHARACTERISTICS, FLIGHT TEST EVALUATIONS, AND SIMULATION TESTS OF WARNING AND DETECTION ASPECTS
- FAA TESTED BOTH COOPERATIVE AND NON COOPERATIVE SYSTEMS

MANUFACTURER	TYPE OF SYSTEM
GENAVE	R-F PASSIVE (BEACON)
CYGNED	AIRBORNE RADAR
BENDIX	R-F PASSIVE (BEACON)
KOLLSMAN	OPTICAL INFRA-RED
LORAL	OPTICAL INFRA-RED
ROCK AVIONICS	OPTICAL INFRA-RED
LOCKHEED	R-F INTERROGATE-TRANSPOND
VEGA	R-F INTERROGATE-TRANSPOND

PWI -WHAT HAVE WE LEARNED

- PWI IS NO CHEAPER THAN ACAS OR IPC FOR LESS PROTECTION
- PWI MUST BE COOPERATIVE (PERFORMANCE OF NON-CO-OPERATIVE SYSTEM WAS UNSATISFACTORY)
- PWI MUST PROVIDE RELATIVE BEARING (SECTOR) INFORMATION TO PILOT SINCE SIMPLE PRESENCE INFORMATION NOT SUFFICIENT TO ENABLE PILOT TO TAKE CORRECT EVASIVE ACTION
- NARROW SECTOR DETECTION IS DESIRABLE, BUT COSTS INCREASE AS SECTOR SIZE IS NARROWED
- MOST PROMISING DESIGN IS OPTICAL PWI DETECTING INFRA-RED RADIATION FROM XENON STROBE LIGHTS

PWI PLANS

- FOUR ROCK AVIONICS STROBE DETECTION SYSTEMS ARE NOW BEING FIELD TESTED BY GENERAL AVIATION OWNERS
- OBJECTIVE: TO DETERMINE USEFULNESS/UTILITY OF THE DEVICES IN HIGH DENSITY AREAS

  TO GET AN INDICATION OF THE USER ACCEPTANCE OF THIS TYPE OF DEVICE
- TESTS WILL LAST APPROXIMATELY ONE YEAR
- ADVISORY CIRCULAR MAY RESULT IN EQUIPPAGE RECOMMENDATIONS
  - STROBES
  - I/R SYSTEM

PWI

- PWI IS NOT AN ALTERNATIVE TO ACAS, BCAS OR IPC
  - DOES NOT WORK UNDER IFR CONDITIONS
  - PROVIDES LIMITED INFORMATION
  - ALL PWI SYSTEMS ARE COOPERATIVE AND AT LEAST AS EXPENSIVE AS AN ACAS, DABS PLUS IPC, OR TRANSPONDER WITH ENCODER
- ROLE - LOW COST "SEE AND AVOID" DEVICE FOR GENERAL AVIATION
- CONCLUSION
  - A VIABLE TECHNOLOGY DOES NOT EXIST AT THE PRESENT TIME
  - AS NEW TECHNIQUES BECOME AVAILABLE WE WILL CONTINUE TO EVALUATE

DEVELOPMENT APPROACHES

- NO SINGLE PANACEA EXISTS
- ALL SYSTEMS HAVE LIMITATIONS
  - PERFORMANCE
  - COVERAGE
  - COST
  - AVAILABILITY
- NEED PROPER MIX
- VOLUNTARY APPROACH WHERE POSSIBLE

D. COMPARISON OF OVERLAPPING DEVELOPMENT PROGRAMS

RATIONALE OF DEVELOPMENT PROGRAMS

- CONFLICT ALERT (TERMINAL)
- ACAS
- BCAS
- IPC
- PWI

CRITERIA

- PROVIDE IMPROVED PROTECTION TO:
  - AIR CARRIER VS GENERAL AVIATION
  - AIR CARRIER VS AIR CARRIER
  - AIR CARRIER VS MILITARY
  - GENERAL AVIATION VS GENERAL AVIATION AND MILITARY
- WHERE - INSIDE AND OUTSIDE SURVEILLANCE
- SOLUTION MUST POSSESS THE FOLLOWING CHARACTERISTICS
  - BE COMPATIBLE WITH THE ATC SYSTEM
  - BUILD ON PRESENT SYSTEM
  - MINIMIZE COSTS BOTH TO USER AND GOVERNMENT

	AIRPORT	ENROUTE/ TERMINAL	REQUIRES SURVEILLANCE	TIME
MORE TRANSPONDERS	YES	YES	YES	NOW
CONFLICT ALERT	YES	YES	YES	NOW/1 YR.
BCAS	NO	YES	NO	2 YRS.
ACAS	NO	YES	NO	NOW
IPC	YES	YES	YES	5 YRS.

CONFLICT ALERT

- NEAR TERM
- ENHANCEMENT TO PRESENT ATC SYSTEM
  - ENROUTE IMPLEMENTATION COMPLETE
  - TERMINAL UNDER DEVELOPMENT
  - TRANSPONDERS/ENCODERS NEEDED
- TERMINAL IS DIFFICULT PROBLEM
  - SURVEILLANCE IMPROVEMENT DESIRABLE
- OPERATIONAL TESTING IN 1977

BCAS

- LOWER COST FOR PUBLIC PASSENGER PROTECTION
- BROADER COVERAGE -- INTERNATIONAL
- BUILDS UPON EXISTING EQUIPMENTS
- PROTECTION AVAILABLE IN TIME FRAME SIMILAR TO ACAS
- SUPPLEMENT TO IPC OUTSIDE OF IPC COVERAGE

IPC

- PROTECTION FOR ALL USERS WITHIN DABS SURVEILLANCE
  - ATC COMPATIBLE BUT YET INDEPENDENT
  - DATA LINK
  - ADAPTABLE TO ALL CHANGES
  - HIGH DENSITY SOLUTION
- ECONOMICALLY VIABLE FOR GENERAL AVIATION AS DABS ADD-ON ON VOLUNTARY BASIS
- GOOD QUALITY PROTECTION INCLUDING PWI
- COOPERATES WITH BCAS

E. FIVE-POINT AIRCRAFT SEPARATION ASSURANCE PROGRAM

FAA

Aircraft Separation Assurance Program

AIRCRAFT SEPARATION ASSURANCE PROGRAM

- CONFLICT ALERT (TERMINAL)
- IFR FLIGHT PLAN REQUIREMENTS
- INCREASED USE OF TRANSPONDERS AND ALTITUDE ENCODERS
- BEACON COLLISION AVOIDANCE SYSTEM (BCAS)
- INTERMITTENT POSITIVE CONTROL (IPC)

TERMINAL CONFLICT ALERT - PROGRAM

STATUS:

- UNDER DEVELOPMENT BY UNIVAC (ARTS III)
  - INITIAL SERVICE FOR "CONTROLLED" AIRCRAFT ONLY (IFR/IFR)
  - ADDITIONAL ENHANCEMENTS PLANNED TO ADD UNCONTROLLED AIRCRAFT (IFR/VFR WITH TRANSPONDERS AND ENCODERS)
- POSSIBILITY OF ADDING CONFLICT ALERT TO ARTS II NOW UNDER STUDY (REQUIRES TRACKING)

INTERRELATION WITH OTHER PROGRAMS

- FOR EFFECTIVE OPERATION TRANSPONDERS AND ALTITUDE ENCODERS REQUIRED
- DEPENDS ON SURVEILLANCE (ATCRBS/DABS) COVERAGE
- MUST BE INTERFACED WITH IPC

TERMINAL CONFLICT ALERT - SCHEDULE

ARTS III CONFLICT ALERT

- TEST AND EVALUATION AT NAFEC COMPLETE — FEB 77
- TEST AND EVALUATION AT FIELD SITE COMPLETE — JUNE 77
- IMPLEMENTATION BEGIN — MARCH 78
- IMPLEMENTATION COMPLETE — MARCH 79

TERMINAL CONFLICT ALERT - COSTS
($ MILLION)

	PRIOR TO FY-76	JAN 76 FY -76	JAN 77 FY -77	JAN 78 FY -78	JAN 79 FY -79	JAN 80 FY -80	JAN 81 -85 FY-81 THRU 85	TOTALS
FAA COSTS								
R & D		.3	.6	.5	.2			1.6
F & E		.1	.1	1.7	1.7			3.6
TOTAL		.4	.7	2.2	1.9			5.2

IFR FLIGHT PLAN REQUIREMENTS

PROPOSAL: PUBLIC TRANSPORTATION TO FILE IFR FLIGHT PLANS WHENEVER POSSIBLE, TO TAKE FULL ADVANTAGE OF AVAILABLE ATC SERVICES

- ALL LARGE OR TURBINE POWERED MULTI ENGINE AIRPLANES OPERATED UNDER PART 91?
- ALL AIR TAXI AIRPLANES CARRYING TEN (10) OR MORE PASSENGERS OPERATED UNDER PART 135?
- ALL AIR CARRIER AIRPLANES OPERATED UNDER PART 121?
- ALL TRAVEL CLUB AIRPLANES OPERATED UNDER PART 123?

STATUS: EXAMINATION UNDERWAY OF:

- PRECISE DEFINITION OF AFFECTED AIRCRAFT SEGMENT: ALL AIR TAXIS, ALL AIRCRAFT CARRYING 10 OR MORE PASSENGERS
- IMPACT OF RULEMAKING ON THAT SEGMENT OF THE AVIATION COMMUNITY AFFECTED
- THE IMPACT ON THE FAA
  - A AUTOMATION SYSTEM
  - B CONTROLLER WORK LOAD

INCREASED USE OF TRANSPONDERS AND ALTITUDE ENCODERS - HIGHLIGHTS

- IMPROVES SURVEILLANCE
- BUILDS ON PRESENT SYSTEM
- EQUIPMENT IS AVAILABLE
- ALL OF AIR CARRIER AND MILITARY ALREADY EQUIPPED
- 70% OF GA ALREADY HAVE TRANSPONDERS AND 10% HAVE ENCODERS
- THROUGH ATC SYSTEM PROVIDES PROTECTION FOR ALL IFR AIRCRAFT AND INDIRECT PROTECTION TO THE VFR AIRCRAFT INVOLVED WITH AN IFR AIRCRAFT
- BOTH NATIONAL AND INTERNATIONAL STANDARDS ALREADY EXIST
- REQUIRED FOR MINIMUM SAFE ALTITUDE WARNING AND EN ROUTE CONFLICT ALERT
- REQUIRED FOR OTHER ELEMENTS OF ASA PROGRAM: TERMINAL CONFLICT ALERT, BCAS, IPC

INCREASED USE OF TRANSPONDERS AND ALTITUDE ENCODERS

PROPOSAL: EXAMINE APPROACHES TO INCREASE THE USE OF TRANSPONDERS AND ENCODERS, E.G.,

- BY AIRSPACE
  - ALL ARTS III LOCATIONS?
  - GROUP III TCA'S?
  - ALL CONTROLLED AIRSPACE?

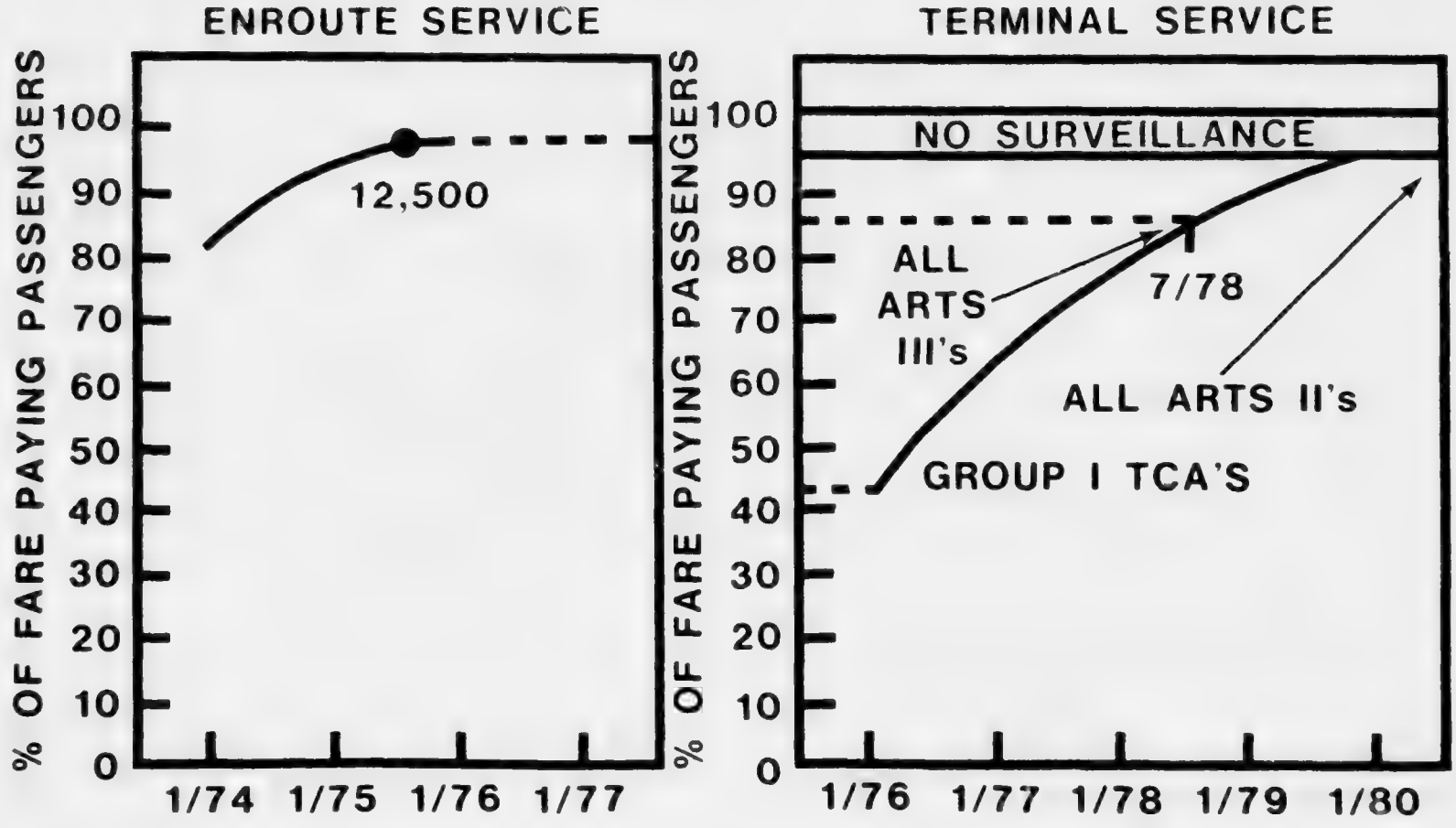
  BY AIRCRAFT
  - THROUGH LICENSING REQUIREMENTS?
  - ALL AIRCRAFT WITH 10 OR MORE SEATS?
  - ALL AIRCRAFT (EXCLUDING GLIDERS, EXPERIMENTALS ETC.)?

INCREASED USE OF TRANSPONDERS AND ALTITUDE ENCODERS

STATUS: EXAMINATION UNDERWAY OF IMPACT ON:

- ATCRBS
- NAS STAGE A AND ARTS III AUTOMATION SYSTEMS
- PROVIDING INCREASED CONTROL AND ADVISORY SERVICES (CONTROLLER WORKLOAD)
- OTHER ELEMENTS OF ASA PROGRAM IF RULE MAKING IS HELD OFF UNTIL DABS TRANSPONDER SPECIFICATION IS AVAILABLE (JAN 80)

TRANSPONDERS AND ENCODING ALTIMETERS - COVERAGE



INCREASED USE OF TRANSPONDERS AND ALTITUDE ENCODERS

INTERRELATION WITH OTHER PROGRAMS:

- CONFLICT ALERT
- REQUIRED FOR MSAW
- AIDS AND IMPROVES SURVEILLANCE COVERAGE
- BASIS FOR BCAS
- DABS
- REQUIRED FOR IPC

TRANSPONDERS AND ALTITUDE ENCODERS - COSTS
($ MILLION)

	PRIOR TO FY-76	JAN 76 FY-76	JAN 77 FY-77	JAN 78 FY-78	JAN 79 FY-79	JAN 80 FY-80	JAN 81 -85 FY-81 THRU 85	TOTALS
USER COSTS								
AIR TRANSPORTATION								
MILITARY					5.5	3.7		9.2
GENERAL AVIATION					42.6	41.4		84.0
TOTAL					48.1	45.1		93.2

BEACON COLLISION AVOIDANCE SYSTEM (BCAS)

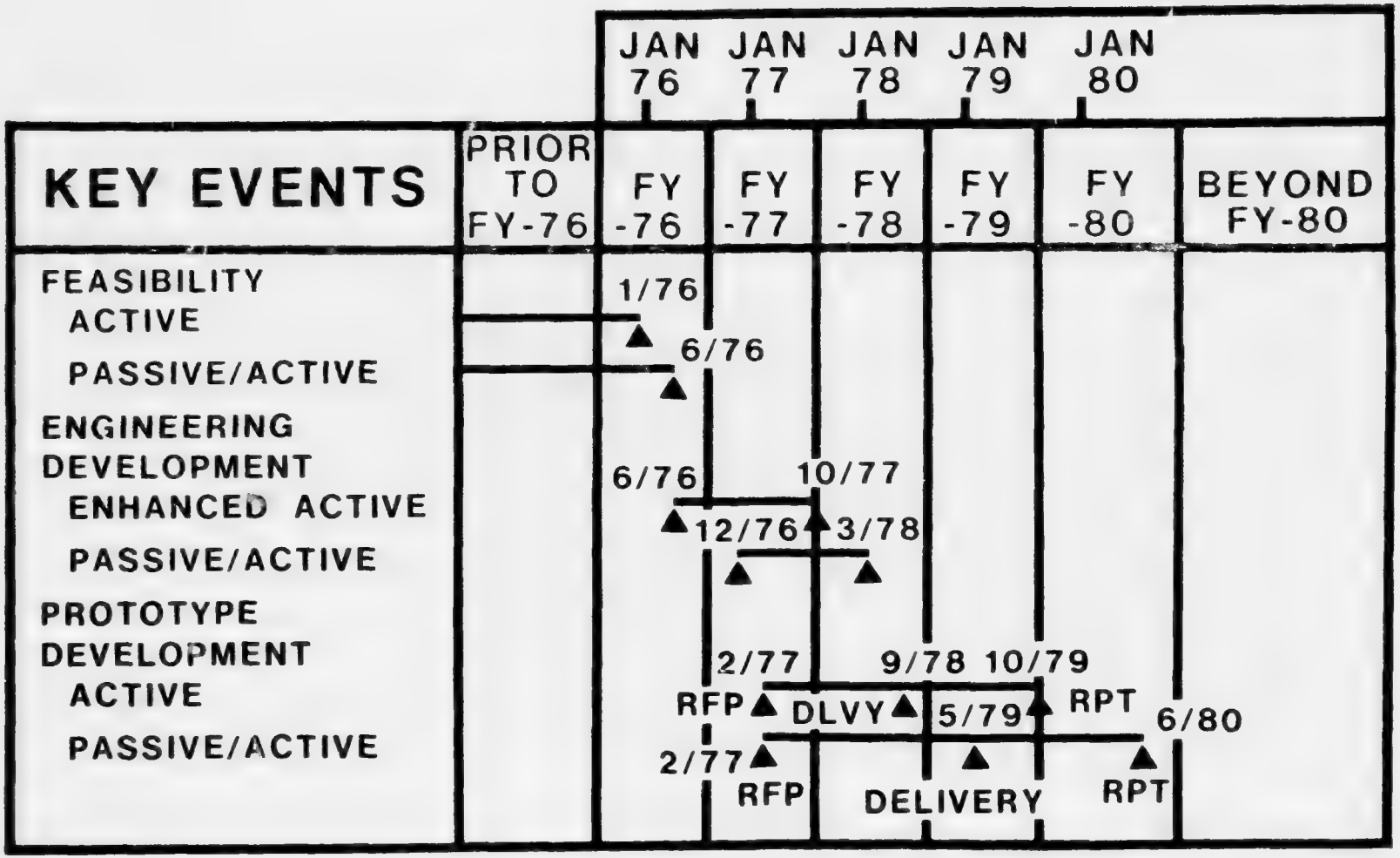
STATUS

- DEVELOPMENTAL
- FEASIBILITY OF BOTH ACTIVE AND PASSIVE/ACTIVE DEMONSTRATED
- REQUEST FOR PROPOSALS UNDERWAY FOR PROTOTYPE SYSTEMS

INTERRELATION WITH OTHER PROGRAMS

- REQUIRES TRANSPONDERS AND ALTITUDE ENCODERS
- ATC PROCEDURES
- IPC INTERFACE

BCAS - SCHEDULE



BCAS - COSTS
($ MILLION)

	PRIOR TO FY-76	JAN 76 FY -76	JAN 77 FY -77	JAN 78 FY -78	JAN 79 FY -79	JAN 80 FY -80	JAN 81 -85 FY-81 THRU 85	TOTALS
FAA COSTS								
R & D		1.1	5.4	7.5	3.5	1.9		19.4
F & E								
TOTAL								$19.4M
AIR TRANSPORTATION USER COSTS								
PUBLIC							113	113
FEDERAL							52	52
PRIVATE							142	142
TOTAL								$307M
TOTAL								$326M

INTERMITTENT POSITIVE CONTROL (IPC)

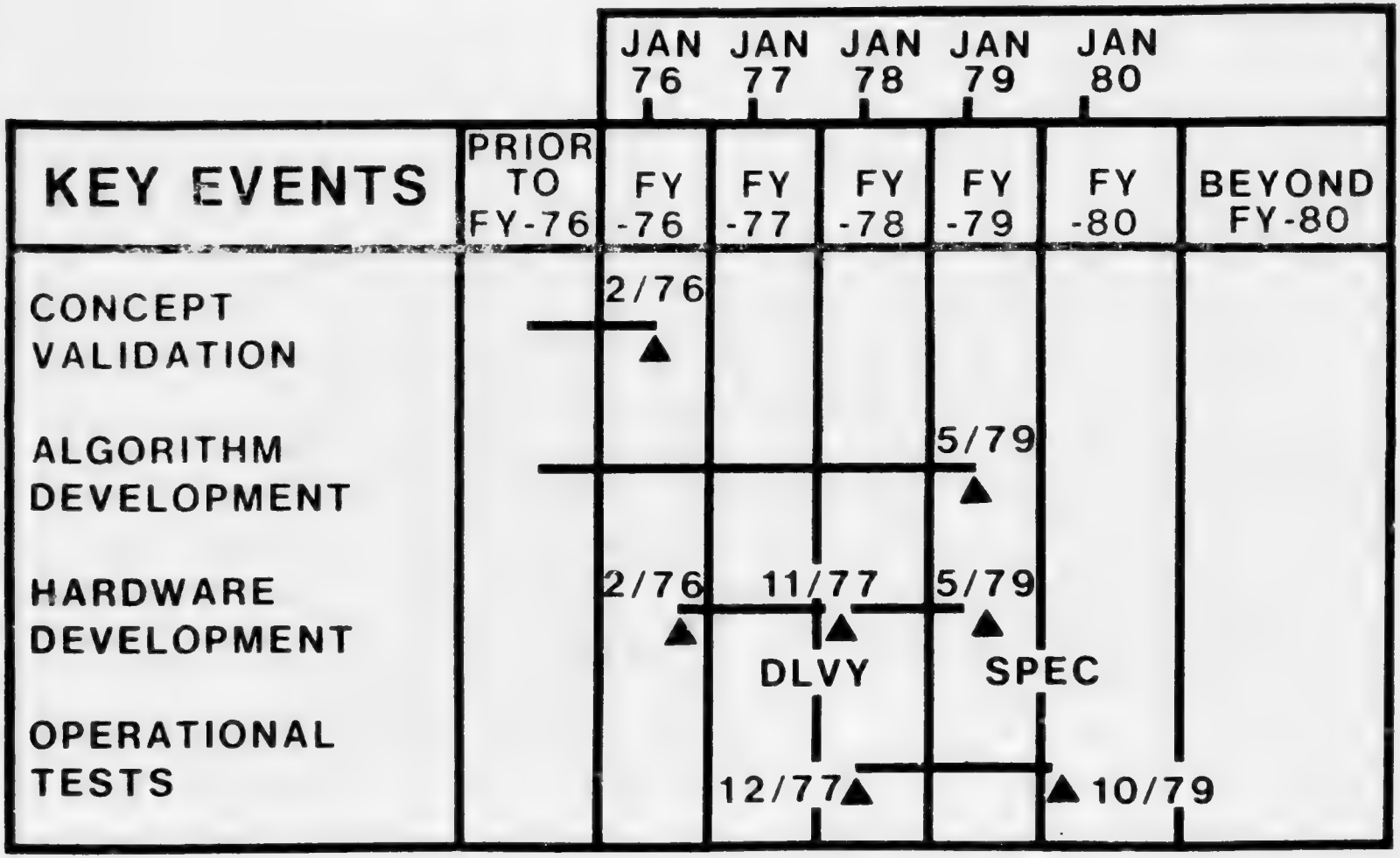
STATUS

- DEVELOPMENTAL
- FEASIBILITY DEMONSTRATION COMPLETED
- CONTRACT UNDERWAY FOR ENGINEERING MODEL OF DABS/IPC

INTERRELATION WITH OTHER PROGRAMS

- REQUIRES DABS DATA LINK
- INTERFACE WITH BCAS
- REQUIRES TRANSPONDERS (ATCRBS OR DABS) AND ENCODERS
- CONTROLLER INTERFACE
- INTERFACES WITH CONFLICT ALERT
- CHANGES IN ATC PROCEDURES

IPC - SCHEDULE

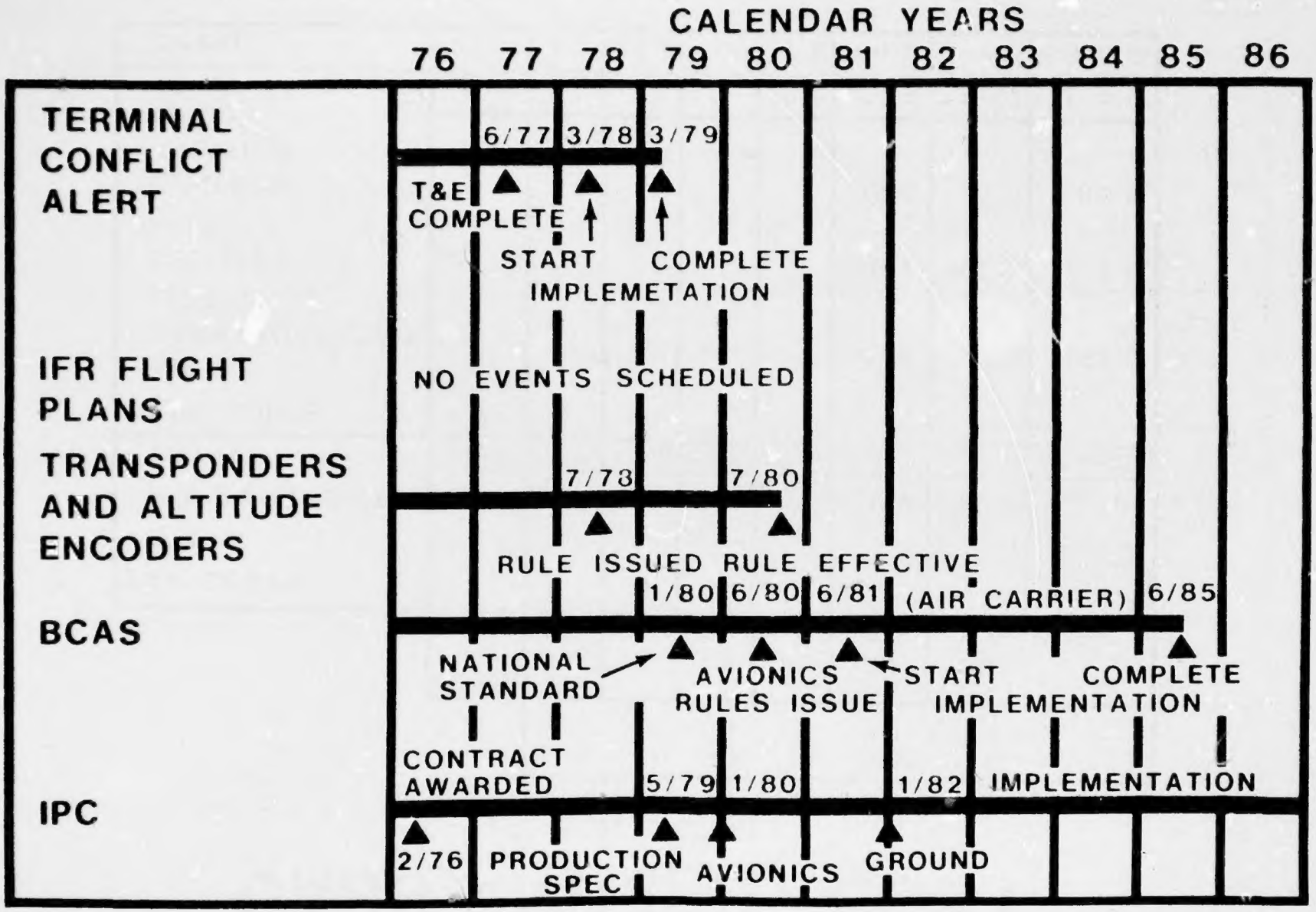


DABS AND IPC - COST

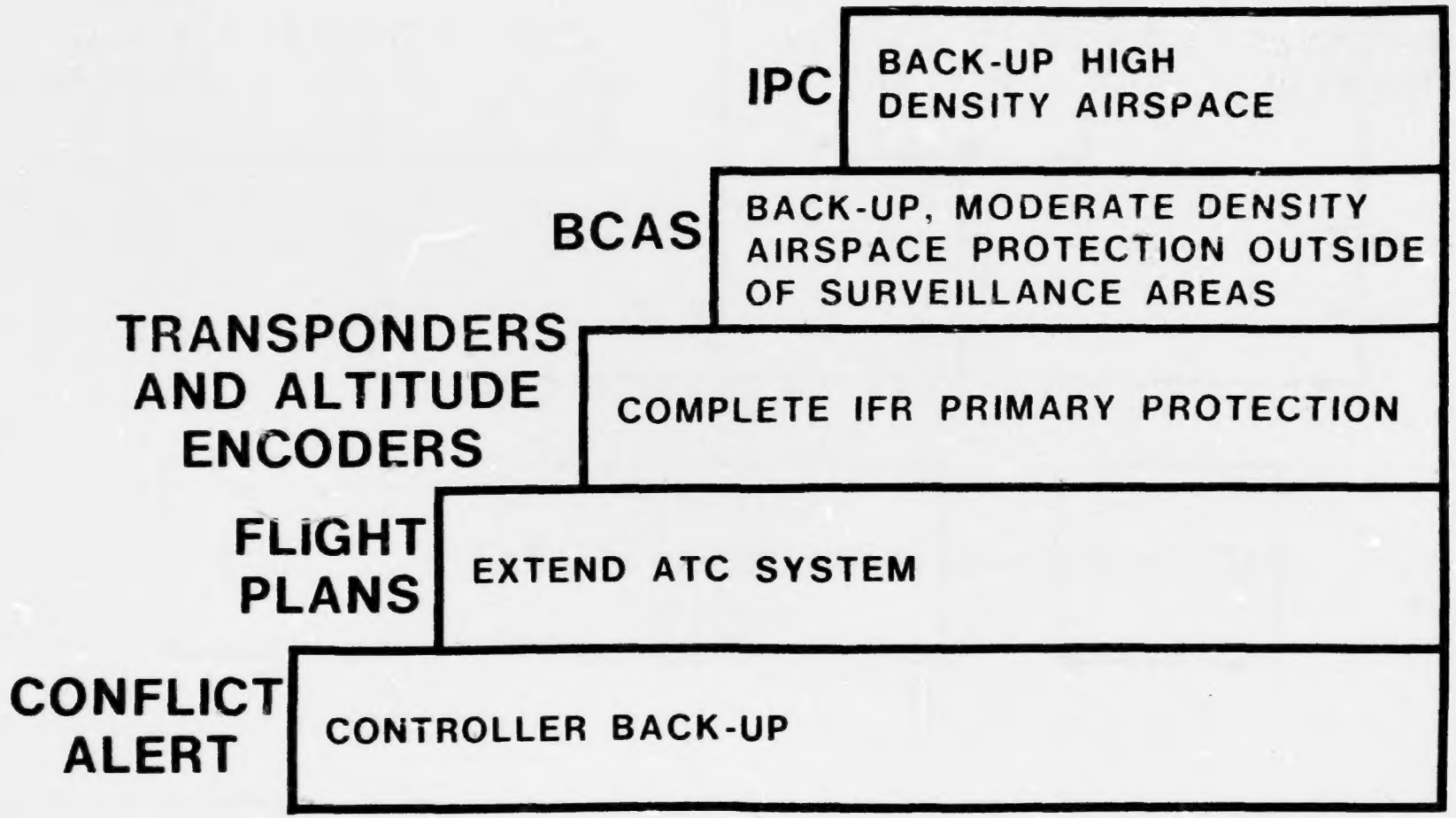
($ MILLION)

	PRIOR TO FY-76	JAN 76 FY -76	JAN 77 FY -77	JAN 78 FY -78	JAN 79 FY -79	JAN 80 FY -80	JAN 81 -85 FY-81 THRU 85	TOTALS
FAA COSTS								
R & D	20.4	8.2	15.8	13.5	7.8	4.2	1.3	71.2
F & E (150 SITES)					5.0	20.0	50.0	75.0
TOTAL	20.4	8.2	15.8	13.5	12.8	24.2	51.3	146.2
USER COSTS								
AIR TRANSPORTATION (100%)						15.6	47.7	63.3
MILITARY (100%)						40.7	172.1	212.8
GENERAL AVIATION (30%)						15.6	72.9	88.5
TOTAL					0.0	71.9	292.7	364.6
TOTAL	20.4	8.2	15.8	13.5	12.8	96.1	344.0	$510.8

SUMMARY - MAJOR EVENTS



AIRCRAFT SEPARATION ASSURANCE OVERVIEW



ASA PROGRAM MANAGMENT